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AFATL-TR-76-84 VOLUME II

AD B018527

SYNERGISTIC EFFECTS OF MINEFIELDS AND COVERING FIRE (SEMAC) COMPUTER MODEL

VOLUME II. ANALYST'S MANUAL

BOOZ, ALLEN & HAMILTON INC.
362 BEAL PARKWAY N.W.
FORT WALTON BEACH, FLORIDA 32548

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FINAL REPORT: JUNE 1975 - APRIL 1976

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This computer simulation model, referred to as SEMAC, provides the methodology and analytical techniques required for evaluating the synergistic effects of minefields and covering fire. The model was specifically designed to consider mixed minefields, armored vehicle tactics, and the employment of combinations of different types of direct and indirect fire. Methodology is included to evaluate the effectiveness of rollers and plows, as well as line charges and fuel air explosive devices employed in a next pg

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minesweeping role. SEMAC is an event-oriented model which uses Monte Carlo techniques to simulate the passage of up to 100 intruder targets of up to five types through an engagement area. The model can evaluate the effectiveness of up to 20 direct fire defenders and up to 10 indirect fire volley aimpoints. The computer program was specifically designed for the Control Data Corporation 6600 computer system at Eglin Air Force Base, Florida.

PREFACE

This report documents work accomplished during the period 10 June 1975 through 10 April 1976 by Booz, Allen & Hamilton, Inc., 362 Beal Parkway, N.W., Fort Walton Beach, Florida, under Contract Number F08635-75-C-0151 with the Air Force Armament Laboratory, Armament Development and Test Center, Eglin Air Force Base, Florida. The program monitor for the Armament Laboratory was Mr. Charles A. Reynolds (DLYW).

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

J R Murray

J. R. MURRAY
Chief, Weapon Systems Analysis Division

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LIST OF SYMBOLS AND ABBREVIATIONS - MATHEMATICAL MODEL

SYMBOL OR ABBREVIATION	EQUIVALENT IN SIMULATION MODEL	DEFINITION	UNITS
a	ALWRAT	The ratio of the length of the target to the width of the target.	none
a_1, a_2	A1,A2	An intermediate factor used in computing the single shot probability of damage.	none
b_1, b_2	B1,B2	An intermediate factor used in computing the single shot probability of damage.	none
CEP	ACEP(5,2)	The circular error probable in the normal plane.	feet or mils
$D_{(ik)}$	DIS	The distance from the ith (detonating mine or exploding munition) to the kth mine.	feet
D_F	DFTFAE	The distance in front of the target where the fuel air explosive sweeping device detonates.	feet
$D_{MPI(i)}$		Mean point of impact in deflection.	feet
D_{MT}	DISTPD	The distance between the mine and the target.	feet
D_O	DO	The distance in deflection from a target to an indirect fire round impact point.	feet
DEP	DEP(10)	The deflection error probable in the ground plane.	feet

LIST OF SYMBOLS AND ABBREVIATIONS - MATHEMATICAL MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN SIMULATION MODEL	DEFINITION	UNITS
DSSP	DSSP	The single shot probability of hit in deflection.	none
EMD		The effective miss distance.	feet
H_T	TARHT(5)	The height of the intruder target.	feet
I	ANGIMP(10)	The weapon impact angle.	degrees
L_{ET}	ETL	The effective target length.	feet
L_P		The pattern length of the indirect fire weapon.	feet
L_{SH}	SHADOL	The target shadow length.	feet
L_T	TARL(5)	The intruder target length.	feet
MAE_b		Mean area of effectiveness for blast.	square feet
MAE_f		Mean area of effectiveness for fragmentation.	square feet
N_S	NSUB(5)	Number of submunitions.	none
N_t		The number of complete fuze cycles.	none
P	PRBITY	An interpolated value determined by Subroutine TABINT.	none
P_{DF}	PDLCF	The probability of mine detonation within the FAE pattern.	none

LIST OF SYMBOLS AND ABBREVIATIONS - MATHEMATICAL MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN SIMULATION MODEL	DEFINITION	UNITS
P_{DUD}	DUDPRB(7)	The probability that the mine type is a dud.	none
P_{HD}		The probability of damage given a hit.	none
P_q, P_{q+1}	PROBIL(840)	Probability values from tables.	none
R	AREL(5,2)	The reliability of the direct fire round.	none
R_F	RADFAE	The radius of the FAE effects.	feet
$R_{MPI(i)}$		The mean point of impact in range.	feet
R_N	RSTART	A random number from a normal distribution.	none
$R_{N1}, R_{N2}, R_{N3}, R_{N4}$	RSTART	Random numbers from a normal distribution.	none
R_O	RO	The distance in range from a target to an indirect fire round impact point.	feet
R_I	PATRAD(5)	The radius of the ICM pattern.	feet
R_q, R_{q+1}	RANGPR(840)	Range values from tables.	none
R_S	RELSUB(5)	The reliability of the submunition.	none
R_T	TARRAD(5)	The radius of the intruder target.	feet

LIST OF SYMBOLS AND ABBREVIATIONS - MATHEMATICAL MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN SIMULATION MODEL	DEFINITION	UNITS
REP	AREP(20)	The range error probable in the ground plane.	feet
RSSP	RSSP	The range single shot probability of hit.	none
SSP_D	SSPD	The single shot probability of damage.	none
T_H	HORIZ	The average horizontal dimension for the target.	feet
t_{off}	SECOFF(7)	The duration of the inactive portion of the fuze timing cycle.	seconds
t_{on}	SECON(7)	The duration of the active portion of the fuze timing cycle.	seconds
t_r		The simulation time when a given event occurs.	seconds
t_s	IT	The random starting point for the fuze timing cycle.	seconds
T_t		A time period relating to the fuze timing cycle.	seconds
T_V	VERT	The vertical dimension for the target.	feet
U_{RN}	RN	A random number from a uniform distribution.	none
V	V	An intermediate variable used in obtaining a normal random number.	none

LIST OF SYMBOLS AND ABBREVIATIONS - MATHEMATICAL MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN SIMULATION MODEL	DEFINITION	UNITS
VA_N		The vulnerable area of the target in the normal plane.	square feet
W_{ET}	ETW	The effective target width.	feet
W_P		The width of the improved conventional munition pattern.	feet
$X_{A(n)}$	AIMPTX(50)	The X coordinate of the nth sortie aimpoint in the map coordinate system.	feet
$X_{D(i)}$		The X coordinate of the ith direct fire area entrance or exit boundary.	feet
$X_{D(k)}$	XODEF(20)	The X coordinate of the kth defender in the travel path coordinate system.	feet
$X_{M(i)}$		The X coordinate of the ith mine in the map coordinate system.	feet
$X'_{M(i)}$		The X coordinate of the ith mine with respect to the nominal sortie aimpoint.	feet
$X_{MR(i)}$	OBX	The X coordinate of the ith mine in the travel path coordinate system.	feet
$X_{RDMPI(j)}$	XDMP(10,10)	The X coordinate of the jth desired mean point of impact for an indirect fire round.	feet

LIST OF SYMBOLS AND ABBREVIATIONS - MATHEMATICAL MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN SIMULATION MODEL	DEFINITION	UNITS
$X_{RDPI(j)}$	DMPIIX(10,10)	The X coordinate of the jth desired point of impact with respect to the origin of the volley pattern.	feet
$X_{RI(j)}$	ROTDMPX(10,10)	The X coordinate of the jth desired point of impact of the indirect fire round in the travel path coordinate system.	feet
X_{R1}	XROAD(11)	The X coordinate of the travel path segment starting point in the map coordinate system.	feet
$X_{T(j)}$	TGTXOL(100)	The X coordinate of the jth target in the travel path coordinate system.	feet
X_{TO}	XFIX	The target offset distance while diverting around a damaged target.	feet
$X_{VAP(i)}$		The X coordinate of the ith volley aimpoint origin in the travel path coordinate system.	feet
$XO_{VAP(i)}$	XOVP(10)	The X coordinate of the ith volley aimpoint origin in the map coordinate system.	feet
$Y_{A(n)}$	AIMPTY(50)	The Y coordinate of the nth sortie aimpoint in the map coordinate system.	feet

LIST OF SYMBOLS AND ABBREVIATIONS - MATHEMATICAL MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN SIMULATION MODEL	DEFINITION	UNITS
$Y_{D(i)}$		The Y coordinate of the ith entrance or exit direct fire area boundary.	feet
$Y_{D(k)}$	YODEF(20)	The Y coordinate of the kth defender in the travel path coordinate system.	feet
Y_{DIV}	YDIV(100)	The Y coordinate of the damaged target which must be diverted around.	feet
$Y_{DR(i)}$		The Y coordinate of the ith direct fire entrance or exit boundary.	feet
$Y_{M(i)}$		The Y coordinate of the ith mine in the map coordinate system.	feet
$Y'_{M(i)}$		The Y coordinate of the ith mine with respect to the nominal sortie aimpoint.	feet
$Y_{MR(i)}$	OBY	The Y coordinate of the ith mine in the travel path coordinate system.	feet
$Y_{PC(i)}$		The center of the pattern for the ith FAE detonation position.	feet
$Y_{PI(i)}$		The closest point of approach to the target of the effects of the ith FAE detonation.	feet
$Y_{PO(i)}$		The furthest point from the target of the ith FAE detonation effects.	feet

SYMBOL OR ABBREVIATION	EQUIVALENT IN SIMULATION MODEL	DEFINITION	UNITS
$Y_{RDMPI(j)}$	YDMP(10,10)	The Y coordinate of the jth desired mean point of impact for an indirect fire round.	feet
$Y_{RDPI(j)}$	DMPIIY(10,10)	The Y coordinate of the jth desired point of impact with respect to the origin of the volley pattern.	feet
$Y_{RI(j)}$	ROTDMPY(10,10)	The Y coordinate of the jth desired point of impact of the indirect fire round in the travel path coordinate system.	feet
Y_{R1}	YROAD(11)	The Y coordinate of the travel path segment starting point in the map coordinate system.	feet
$Y_{T(j)}$	TGTYNW(100)	The Y coordinate of the jth target in the travel path coordinate system.	feet
$Y_{VAP(i)}$		The Y coordinate of the ith volley aimpoint origin in the travel path coordinate system.	feet
$YO_{VAP(i)}$	YOVP(10)	The Y coordinate of the ith volley aimpoint origin in the map coordinate system.	feet
$\Delta X_{(ij)}$	DISTPD	The distance between the mine and the target.	feet

LIST OF SYMBOLS AND ABBREVIATIONS - MATHEMATICAL MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN SIMULATION MODEL	DEFINITION	UNITS
$\Delta Y_{(ij)}$	DIRDIS(100)	Range distance that must be traveled by the jth target to reach the point of closest approach to the ith mine.	feet
σ_{AD}	SIGAD(50)	The aiming error standard deviation in deflection.	feet
σ_{AR}	SIGAR(50)	The aiming error standard deviation in range.	feet
σ_{BD}	SIGBD(50)	The ballistic error standard deviation in deflection.	feet
σ_{BR}	SIGBR(50)	The ballistic error standard deviation in range.	feet
θ	THETA	The angle defining the direction of travel of the delivery aircraft (measured clockwise from the positive Y axis).	degrees
$\theta_{F(i)}$	AYYVP(10)	The angle defining the direction of attack for the indirect fire volley aimpoint, measured clockwise from the positive Y axis in the map coordinate system.	degrees
θ_{FR}	DIRATK(10)	The angle defining the direction of attack for the indirect fire volley aimpoint in the travel path coordinate system.	degrees

LIST OF SYMBOLS AND ABBREVIATIONS - MATHEMATICAL MODEL (CONCLUDED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN SIMULATION MODEL	DEFINITION	UNITS
θ_R	THETR	The angle between the directed travel path segment and the positive X axis in the map coordinate system.	degrees

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
ACEP(5,2)	CEP	An array containing the circular error probable in the normal plane for the defender or intruder targets by type.	feet or mils
ACEP1		The circular error probable in the normal plane for direct fire rounds.	feet or mils
ADEP(20)		An array containing the deflection error probable for the direct fire round.	feet
ADEP1,ADEP2		The deflection error probable for direct fire rounds.	feet
AEI(5,5,4)		An array containing flags indicating either a defender firing at an intruder or an intruder firing at a defender and the value of the effectiveness index.	none
AEV		The value of the effectiveness index for direct fire weapons.	various
AI(20)		An array containing the angle of fall at weapon impact for direct fire weapons.	degrees
AIMPTX(50)	$X_{A(n)}$	An array containing the X coordinates of the sortie aimpoints in the map coordinate system.	feet

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
AIMPTY(50)	$Y_{A(n)}$	An array containing the Y coordinates of the sortie aimpoints in the map coordinate system.	feet
AI1,AI2		The angle of fall at impact for a direct fire round.	degrees
AKIL		An internal program variable used in printing optional output.	none
ALNGLC		The length of the line charge used as a sweeping device.	feet
ALWRAT	a	The ratio of the length of the target to the width of the target.	none
AM		A variable used for temporary storage of the maximum value of the target length and target width.	feet
ANG		A variable used as temporary storage for the angle at which the indirect fire volleys are delivered.	radians
ANGIMP(10)	I	The angle of impact for the indirect fire volley delivered at each aimpoint.	degrees
APHD		The probability of damage given a hit for a weapon type employed against a target type.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
AREL(5,2)	R	The reliability of the direct fire round fired by either defender or intruder targets by type.	none
AREL1		The reliability of direct fire rounds.	none
AREP(20)	REP	An array containing the range error probable for the direct fire round.	feet
AREP1,AREP2		The range error probable for direct fire rounds.	feet
AWIDLC		The width of the line charge effects.	feet
AYYVP(10)	$\theta_{F(i)}$	The direction of attack for each indirect fire aimpoint, measured clockwise from the positive Y axis in the map coordinate system.	degrees
A1		The difference in Y coordinates of the end points of a travel path segment.	feet
A2		The difference in X coordinates of the end points of a travel path segment.	feet
BCEP		The circular error probable in the normal plane for direct or return fire munitions.	feet or mils

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
BIG		The total breach time for a target.	minutes
BIGY		A target Y coordinate used in determining the unit movement of intruder targets.	feet
BREL		The reliability of the direct fire round fired by the intruder or defender.	none
B1	b_1	An internal program variable.	none
B2	b_2	An internal program variable.	none
COSA		The cosine of the angle defining the direction of attack for an indirect fire aimpoint.	none
COSANG		The cosine of the angle defining the direction of attack for an indirect fire aimpoint.	none
COSIMP		The cosine of the angle of fall at impact for an indirect fire round.	none
COST		The cosine of the angle defining the direction of travel of the delivery aircraft.	none
COSTR		The cosine of the angle between the directed travel path segment and the positive X axis in the map coordinate system.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
DBFAE		The distance between fuel air explosive munition aimpoints.	feet
DEFHT(5)		An array containing the height of the defender targets by type.	feet
DEFL(5)		An array containing the length of the defender targets by type.	feet
DEFRAD(5)		An array containing the radius of the defender targets by type.	feet
DEFW(5)		An array containing the width of the defender targets by type.	feet
DEFX(20)		An array containing the X coordinate of the defender in the travel path coordinate system.	feet
DEFY(20)		An array containing the Y coordinate of the defender in the travel path coordinate system.	feet
DELATM(100)		An array containing the time remaining for each intruder to delay while breaching the minefield.	minutes
DELTM		The total time an intruder is delayed while traversing a travel path segment.	minutes

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
DENOM		A variable used in the calculation of single shot probability of damage from indirect fire weapons.	none
DEP(10)	DEP	An array containing the deflection error probable values for each volley aimpoint.	mils
DFTFAE	D_F	The intended distance in front of the intruder for deploying fuel air explosive devices.	feet
DIRATK(10)	θ_{FR}	An array containing the direction of attack for each indirect fire volley aimpoint in the travel path coordinate system.	radians
DIRDIS(100)	$\Delta Y_{(ij)}$	An array containing the range distances to the next event for each target.	feet
DIS	$D_{(ik)}$	The distance between two mines (used for sympathetic detonation evaluations).	feet
DIST(52)		An array containing data used to calculate values of variables used in output of distribution data.	various
DISTPD	D_{MT}, $\Delta X_{(ij)}$	The distance between the mine and the target.	feet

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
DIST5(21,52)		An array containing distribution output data.	none
DLCF		The length of the line charge or the distance between fuel air explosive munition aimpoints.	feet
DMPIIX(10,10)	$X_{RDPI(i)}$	An array containing the X coordinate of the desired mean points of impact for each round delivered at each indirect fire aimpoint.	feet
DMPIIY(10,10)	$Y_{RDPI(j)}$	An array containing the Y coordinate of the desired mean points of impact for each round delivered at each indirect fire aimpoint.	feet
DO	D_O	The distance in deflection from a target to an indirect fire round impact point.	feet
DSQ		The sum of the squares of the distances in range and deflection from a target to an indirect fire round impact point.	feet squared
DSSP	DSSP	The single shot probability of damage in deflection.	none
DUDPRD(7)	P_{DUD}	An array containing the probabilities that the mine types are duds.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
DUMMY		A dummy argument used by RANF.	none
D3DEL		The time required to remove a travel path blockage caused by a damaged target on the travel path flanked by two targets which were damaged while diverting.	minutes
EI(5,5,2)		An array containing the value and type of the effectiveness indice for each intruder target type and each indirect fire weapon type employed.	various
EIVAL		A variable used to store the value of the effectiveness index.	various
ETL	L_{ET}	The effective length of the target.	feet
ETW	W_{ET}	The effective width of the target.	feet
EV1		An internal program variable.	none
EV2		An internal program variable.	none
EV3		An internal program variable.	none
HOL(8)		An array for temporary storage of card images.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
HORIZ	T_H	The average horizontal dimension for the intruder or defender type.	feet
I		An internal program variable.	none
IAP		The sequential sortie aimpoint number.	none
IBIT		An internal program variable.	none
ID		The sequential number for targets which must be diverted around.	none
IDAM		A variable used to signal that a target has been damaged by direct or indirect fire.	none
IDET		The mine detonation flag as determined by Subroutine BOOM.	none
IDISOP		The output option for distribution data: 0 = distributions for output variables are not printed. 1 = distributions for output variables are calculated and printed.	none
IDP(20,15,2)		An array containing numbers specifying sets of delivery parameters used in the direct fire methodology.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
IDP1, IDP2, IDP3		A number specifying a set of delivery parameters used in the direct fire methodology.	none
IEND		The run number counter.	none
IFMT(27)		An array containing the output format for distribution data.	none
IIS		An index number indicating which target is in the next event.	none
IMINE		The sequential mine number.	none
IND		The number specifying the set of delivery parameters for a direct fire munition.	none
INDFA		A flag indicating that a target has encountered an indirect fire volley aimpoint.	none
INPUT		Local storage for the card type.	none
INT(52)		An array containing the intervals over which the distribution data are computed.	none
INTIME(7)		The fuze timing option or target counting option for each mine type: 0 = mine type is always active.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
		1 = mine type has ON/OFF cycle or counts targets before arming.	
INTYP		The intruder type.	none
IOB(5000)		An array of mine data travel path segment boundary data and direct and indirect fire data in packed form (consisting of X and Y coordinates, event type, mine sequential number, and fuze timing cycle starting point or target count for arming).	none
IOUT(15)		An array containing distribution output variables.	none
IPO		A variable containing alpha information indicating that a mine was swept or detonated in the event.	none
IPOS(130)		An array used to store the position in the TMTOFR array of the events in time sequence.	none
IPRINT		The number of the iteration for which detailed information concerning each event is desired.	none
IPRR		An internal program variable used to store the priority of the intruder	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
		that the defenders may fire upon.	none
IRD		An internal program variable.	none
IRN		A variable used for temporary storage of the iteration number.	none
IRNK(7)		A flag controlling the target counting option for mines: 0 = mine will arm and detonate after sensing KOUNT(MT) number of targets. 1 = mine will arm and detonate after sensing a uniform random number of targets varying from one up to KOUNT(MT).	none
IROAD		The travel path segment that the indirect fire volleys will occur on.	none
IRTFIR		A flag indicating whether the intruders may return fire.	none
IRUNS		A replication or iteration counter which varies between 1 and NOIT.	none
ISAVE		An index number indicating which intruder target is in the next event.	none

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
ISBL		An option describing the disposition of swept mines: 0 = swept mines are neutralized. 1 = swept mines are blown-in-place.	none
ISHOT		An internal program variable.	none
ISUB		An internal program variable.	none
ISV		An internal program variable.	none
ISVIFA(30)		An array used to determine which intruders are accessible to fire from the defender forces.	none
ISVLST		A save location for the last value of ISAVE.	none
ISYMP(3)		An array containing the sympathetic detonation options [ISYMP(1) is for mines, ISYMP(2) is for direct fire munitions, and ISYMP(3) is for indirect fire munitions]: 0 = sympathetic detonations are not evaluated. 1 = sympathetic detonations are evaluated.	none
ISYP		A flag to initiate unit movement considerations.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
IT	t_s	The mine random starting time, the target count required for arming, or the direct fire area.	various
ITEMP		An internal program variable.	none
ITEROP		An option for printing the iteration output: 0 = do not print iteration results. 1 = print iteration results.	none
ITEST		An internal program variable.	none
ITGT		Temporary storage for the intruder target number.	none
ITGTPR(5,5)		An array containing the list by type of the order in which the defender forces will fire at the intruders.	none
ITT		An internal program variable.	none
ITYP		Temporary storage for the intruder target type.	none
IVAP		The number of the indirect fire volley aimpoint.	none
IVEL		A program switch that contains a one if all targets are in a delay condition; otherwise, it contains a zero.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
IVPO		An internal program variable.	none
IWD		An internal program variable.	none
IWEPV		The sequential number of the indirect fire round.	none
IWORD		The data for an event in packed format.	none
IWT		Temporary storage for the weapon type.	none
IWTDEF(20)		An array containing the weapon type of each defender.	none
IWTVAP(10)		An array containing the indirect fire weapon type employed at each aimpoint.	none
IX		An internal program variable.	none
IY		An internal program variable.	none
IXYM1		An internal program variable.	none
IXYM2		An internal program variable.	none
I1		An internal program variable.	none
I2		An internal program variable.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
I3		An internal program variable.	none
I4		An internal program variable.	none
I5		An internal program variable.	none
I8		An internal program variable.	none
I14		An internal program variable.	none
J		An internal program variable.	none
JAA		An internal program variable.	none
JFMT(27)		An array containing the program-derived output format for distribution data.	none
JMARK1		A control for printing the output heading.	none
JSELDS(7)		An option for specifying the type of mine pattern distribution for each mine type: 0 = mine pattern is read from cards. 1 = range and deflection values selected from random normal distribution.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
		2 = range and deflection values selected from random uniform distribution. 3 = range value selected from random normal distribution and deflection value selected from random uniform distribution. 4 = range value selected from random uniform distribution and deflection value selected from random normal distribution.	
JT		An internal program variable.	none
J1		An internal program variable.	none
J2		An internal program variable.	none
J3		An internal program variable.	none
J4		An internal program variable.	none
J5		An internal program variable.	none
K		An internal program variable.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
KABOOM(547)		An array containing 32,820 bits for maintaining mine detonation flags.	none
KB		The sequential number for the first intruder target of the same type as the damaged target and behind the damaged target.	none
KDFTTN(100)		An array containing the count of the number of direct fire areas in which each intruder target may receive direct fire.	none
KF		The sequential number for the first intruder target of the same type as the damaged target and in front of the damaged target.	none
KFMT(27)		An array containing the program-derived output format for distribution data.	none
KNOB		The number or the last event to be considered in sympathetic detonation evaluation.	none
KNOBT		A variable used as temporary storage of the type of event to occur.	none
KNRS		The sequential number of the travel path segment.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
KODEI		Temporary storage for the type of effectiveness index used.	none
KOUNT(7)		An array containing the target counts at which the mine types will arm and detonate.	none
KPOS		A variable used for temporary storage of the intruder number.	none
KREAD		A switch indicating whether Subroutine READIN has been used: 0 = READIN has not been used. 1 = READIN has been used.	none
KT		An index number which locates an event in the IOB array.	none
KTMAX		The maximum mine sequential number (used in the sympathetic detonation evaluations).	none
KTMIN		The minimum mine sequential number (used in the sympathetic detonation evaluations).	none
KTS		The location in which the sequential mine number is saved.	none
KTSAV(100)		An array of indice containing the subscript of	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
		the next event to be encountered by each of the targets.	
KTS1		An internal program variable.	none
KZ		An internal program variable.	none
K1		An internal program variable.	none
K2,K3		A flag indicating the direction of direct fire: 1 = a defender firing at an intruder. 2 = an intruder firing at a defender.	none
K5		An internal program variable.	none
K6		An internal program variable.	none
L		An internal program variable.	none
LCFOPT		The option for employing line charge or FAE devices for sweeping: 0 = neither are used. 1 = line charges are employed. 2 = FAE are employed.	none
LCFTT		The target type which deploys the line charge or fuel air explosive sweeping device.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
LDFDPR(5,5)		An array containing the order in which each intruder target type will fire at the defender target types.	none
LEFTIN		The number of targets which have not been destroyed or have not breached the engagement area.	none
LFMT(27)		An array containing the output format for distribution data.	none
LIT		An internal program variable.	none
LL		An internal program variable.	none
M		An internal program variable.	none
MADIV		An indicator which, if greater than zero, specifies that targets must be diverted around.	none
MFMT(27)		An array containing the output format for distribution data.	none
MI		An internal program variable.	none
MIFBT(7)		An array specifying the number of mines within the range of influence for each mine type.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
MINNUM		The number of sympathetic detonations.	none
MODE		The tactical mode to be employed: 1 = bull-through at normal speed with no sweeping. 3 = allow specified targets to sweep minefield.	none
MT		The mine type number.	none
MTFA(50)		An array containing the type of mine dispensed at each aimpoint.	none
MUSH		A code specifying whether the targets have started moving: 0 = the targets have not started moving 1 = the targets have started moving.	none
N		An internal program variable.	none
NAP		The number of sortie aimpoints.	none
NAS(100)		An array containing sequential numbers of the targets associated as a group with the damaged target.	none
NB		An internal program variable.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
NCTAW(100)		An array containing the number of the target leading the column with which each target is associated.	none
ND		A count of the number of direct fire areas.	none
NDEFEA(15,20)		An array containing the sequential defender numbers that may fire into the direct fire areas.	none
NDEFNR		Temporary storage of the number of the defender.	none
NDF		The defender associated with this event.	none
NDFA		A flag indicating that an intruder target has entered a direct fire area.	none
NDFAA		The number of direct fire attack areas.	none
NDFDAM(5)		An array containing the number of defenders damaged by type.	none
NDFWD		The number of defenders.	none
NDFWT		The number of defender weapon types.	none
NDTYP		The defender weapon type.	none
NDVT		The number of targets which must be diverted around.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
NE		An internal program variable.	none
NFMT(27)		An array containing the program-derived output format for distribution data.	none
NGTAW(100)		An array containing the sequential numbers of other targets with which each target is associated as a group.	none
NGTAWT		The total number of targets which are associated as a group with other targets.	none
NGTAW1(100)		An array originally containing the NGTAW array variables (changed when a target is reassociated with another target).	none
NIDBT(5)		An array containing the number of intruders damaged by type.	none
NINTT		Temporary storage of the intruder target type.	none
NITBT(5)		An array containing the number of intruders by type.	none
NKILL(5)		An array containing the number of intruder targets by type damaged by mines.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
NKILLD(5)		An array containing the number of intruders by type damaged by direct fire weapons.	none
NKILLI(5)		An array containing the number of intruders by type damaged by indirect fire weapons.	none
NKILLT		The total number of intruder targets damaged.	none
NLCFCT		A count of the number of line charge or FAE deployment positions along the travel path segment.	none
NLST		The number of sympathetic detonations.	none
NM		The mine type.	none
NMDET(7)		An array containing the number of mines detonated by mine type.	none
NMIN(7)		An array containing the total number of mines of each type emplaced.	none
NMSWPT(7)		An array containing the number of mines of each type detected and neutralized by a target capable of sweeping.	none
NMT		The total number of mine types.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
NOB		The total number of mines within the range of influence of a travel path segment.	none
NOBEVT		The number of events for which optional output is printed.	none
NOBT(100)		An array containing the mine types for mines which are sympathetically detonated.	none
NOBTP2		The type of event obstacle (1 through 7 = active mine; 8 = minefield boundary; 9 through 15 = dud mine; 16 = indirect fire volley aimpoint; 17 = direct fire entry boundary; 18 = direct fire exit boundary; and 19 = point of deployment of line charge or FAE).	none
NOIT		The number of iterations desired for the case.	none
NOSTAT		The number of iterations between each statistical summary.	none
NRAD(5)		An array containing the number of rounds available for each defender weapon type.	none
NRADFD(5)		An array used for temporary storage of the number of rounds available for each defender weapon type.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
NRADFI(5)		An array used for temporary storage of the number of rounds available for each intruder type.	none
NRAI(5)		An array containing the number of rounds available for each intruder type.	none
NRBA		The number of rounds the defender forces must fire before being acquired by the intruder forces.	none
NRFBDT(5)		An array containing the number of rounds fired by each defender type.	none
NRFBIT(5)		An array containing the number of rounds fired by each intruder type.	none
NRFIRD(100)		An array containing the number of rounds fired by each intruder.	none
NRS		The number of travel path segments.	none
NSPLFT		The number of targets remaining which are capable of sweeping.	none
NSTICK(50)		An array containing the number of mines dispensed at each aimpoint.	none
NSUB(5)	N_S	An array containing the number of submunitions for improved conventional munitions.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
NT		The target type number.	none
NTABLE		The number of the probability function to be interpolated.	none
NTB		A number indicating the type of probability table.	none
NTCOL(100)		An array containing column identification for targets which must be diverted around.	none
NTGO		The total number of targets traversing the engagement area.	none
NTGTP		The total number of intruder target types.	none
NTGTYP(100)		An array containing the target type for each intruder target.	none
NTLCIF(10)		An array containing the number of the target leading the column of intruders that initiates the indirect fire at each volley aimpoint.	none
NTLOST		The number of intruder targets which are lost to the mission.	none
NTMAX		The maximum number of intruder types, mine types, and defender types.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
NTN		The intruder number.	none
NTTTCS(5)		An array containing flags describing the sweeping capability of each target type: 0 = the target type has no sweeping capability. 1 = the target type is capable of sweeping at least one mine type.	none
NTTTMD(5)		An array containing flags describing which target types must be diverted around by subsequent targets in the same column: 0 = the target type need not be diverted around. 1 = the target type must be diverted around.	none
NTTTRP(5)		An array containing flags describing which target types are rollers or plows: 0 = the target type is not a roller or plow. 1 = the target type is a roller. 2 = the target type is a plow.	none
NT1		An internal program variable.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
NUM		An internal program variable.	none
NUMCNT		The number of time oriented events which may occur before the distance oriented event.	none
NUMDEF		The defender number.	none
NVAP		The number of the indirect fire volley aimpoint involved in this event.	none
NVFAEA(10)		An array containing the number of volleys fired at each volley aimpoint.	none
NVLIDF(10)		An array containing the number of indirect fire volleys remaining to be fired at each volley aimpoint.	none
NVOL		The number of the indirect fire volley.	none
NW		An internal program variable.	none
NWEPV(10)		An array containing the number of rounds to be employed at each indirect fire volley aimpoint.	none
N1		An internal program variable.	none
N2		An internal program variable.	none

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
N3		An internal program variable.	none
OBX	$X_{MR(i)}$	The X coordinate of the distance oriented event.	feet
OBY	$Y_{MR(i)}$	The Y coordinate of the distance oriented event.	feet
OBYPRT		A location for saving OBY values so that they can be printed.	feet
ORX		An intermediate X coordinate of the mine (used during the initial calculations of the mine position).	feet
ORY		An intermediate Y coordinate of the mine (used during the initial calculations of the mine position).	feet
OUT(16)		An array containing the iteration results to be printed.	none
OUT(21,15)		An array containing the values of the distribution variables to be output.	none
PATRAD(5)	R_p	An array containing the improved conventional munition pattern radius for each weapon type.	none
PDAM		The probability that a target has been damaged by indirect fire.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
PDLCF	P_{DF}	The probability of mine detonation within the line charge or fuel air explosive pattern.	none
PHD(5,5)		An array containing the probability of damage given a hit for each indirect fire weapon type employed against each intruder target type.	none
PI		A variable used to store the value of π.	none
PK		The square of the range at which the probability of target damage is zero.	feet squared
PKK		The probability that a target has been damaged by indirect fire.	none
POWER		A variable used as the exponent in the calculation of the probability of damage given a hit by indirect fire weapons.	none
PPEAF(7)		An array containing the probability that a plowed mine type will function.	none
PRBITY	P	A probability value determined by Subroutine TABINT.	none
PRDTNO(5,7)		An array containing the minimum ranges at which the probability that a mine will detonate is	feet

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
		zero for each mine type and target type.	
PRKLO(5,7)		An array containing the minimum ranges at which the probability that a mine will damage a target is zero for each mine type and target type.	feet
PROBIL(840)	P_q, P_{q+1}	An array of probability values corresponding to the range values stored in RANGPR(840), with the first eight entries specifying the probabilities of mine detection for the first target type and first mine type, the second eight entries specifying the probabilities that a mine of the first type will damage a target of the first type, and the third eight entries specifying the probabilities that a mine of the first type will detonate when encountered by a target of the first type. The next three sets of eight entries contain similar data for Target Type 1 and Mine Type 2, etc.	none
PROBTP(8)		An array used to temporarily store probability values during input operations.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
PRSWDO(5,7)		An array containing the minimum ranges at which the probability that the target will detect a mine is zero for each mine type and target type.	feet
P2		An internal program variable.	none
P3		An internal program variable.	none
P4		An internal program variable.	none
P5		An internal program variable.	none
RADFAE	R_F	The radius of the fuel air explosive effects.	feet
RANGE		The width of the line charge or the square of the radius of the fuel air explosive effects.	feet
RANGPR(840)	R_q, R_{q+1}	An array of range values corresponding to the probability values stored in PROBIL(840), with the first eight entries specifying the ranges corresponding to the probabilities of mine detection for the first target type and first mine type, the second eight entries specifying the ranges corresponding to the probabilities that a mine of the first type	feet

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
		will damage a target of the first type, and the third eight entries specifying the ranges corresponding to the probabilities that a mine of the first type will detonate when encountered by a target of the first type. The next three sets of eight entries contain similar data for Target Type 1 and Mine Type 2, etc.	
RANGTP(8)		An array used to temporarily store range values during input operations.	feet
RELRND(5)		An array containing the reliability of the round for each indirect fire weapon type.	none
RELSUB(5)	R_S	An array containing the reliability of the submunition for each improved conventional munition indirect fire weapon type.	none
REP(10)		The range error probable at each indirect fire volley aimpoint.	feet
RN	U_{RN}	A random number from a uniform distribution.	none
RNG		The distance between the defender and intruder.	feet

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
RNGSV(3)		An array for temporary storage of elements from the PRSWD0, PRKL0, and PRDTN0 arrays.	none
RN1,RN2 RN3,RN4		A normal random number used in computing the mine locations.	none
RO	R_O	The distance in range from a target to an indirect fire round impact point.	feet
ROTDMPX(10,10)	$X_{RI(j)}$	An array containing the X coordinates of the desired mean points of impact for the rounds delivered at each volley aimpoint.	feet
ROTDMPY(10,10)	$Y_{RI(j)}$	An array containing the Y coordinates of the desired mean points of impact for the rounds delivered at each volley aimpoint.	feet
RSP(5)		An array containing the ranges of influence for each target type.	feet
RSPMAX		The maximum range of influence.	feet
RSSP	RSSP	The single shot probability of damage in range.	none
RSTART	R_N	A random number from a normal distribution.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
RUNS		The iteration count.	none
S(100)		An array containing variables controlling the diversion direction: -1 = divert to the left. 1 = divert to the right. 0 = no diversion is required. 999 = the target path blockage has been removed; no diversion is required.	none
SAVE		An internal program variable.	none
SECON(7)	t_{on}	The duration of the active portion of the fuze timing cycle for each mine type.	seconds
SECOFF(7)	t_{off}	The duration of the inactive portion of the fuze timing cycle for each mine type.	seconds
SEED		A number used as a starting value for the random number generator.	none
SHADOL	L_{SH}	The target shadow length.	feet
SIGAD(50)	σ_{AD}	The aiming error standard deviation in deflection (this value multiplied by a normal random number vector is applied to each mine in a sortie).	feet

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
SIGAR(50)	σ_{AR}	The aiming error standard deviation in range (this value multiplied by a normal random number vector is applied to each mine in a sortie).	feet
SIGBD(50)	σ_{BD}	The ballistic error standard deviation in deflection (this value multiplied by a normal random number vector is applied independently to each mine).	feet
SIGBR(50)	σ_{BR}	The ballistic error standard deviation in range (this value multiplied by a normal random number vector is applied independently to each mine).	feet
SINA		The sine of the angle defining the direction of attack for an indirect fire aimpoint.	none
SINANG		The sine of the angle defining the direction of attack for an indirect fire aimpoint.	none
SINIMP		The sine of the angle of impact of the round employed at the indirect fire aimpoint.	none
SINT		The sine of the angle defining the direction of travel of the delivery aircraft.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
SINTR		The sine of the angle between the directed travel path segment and the positive X axis in the map coordinate system.	none
SMALY		An intruder target Y coordinate used in determining the unit movement of targets.	feet
SMLDIS		The smallest distance to the next event for all targets.	feet
SMLDIS1		The smallest distance to the next event for all moving targets.	feet
SOBX		Temporary storage for the mine X coordinate.	feet
SOBY		Temporary storage for the mine Y coordinate.	feet
SRPI		The square root of π.	none
SSPD	SSP_D	The single shot probability of damage.	none
STATAL(5,52)		An array of five quantities (i.e., the sum, the sum of squares, the mean, the variance, and the standard deviation) for each of the 52 parameters for which statistical output is provided.	various
SURVPR		The probability of target survival.	none

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
SWPDEL(100)		An array containing the times required to remove or neutralize mines for each target.	minutes
SYMDDF(5,7)		An array containing the maximum distances at which each direct fire weapon type can cause a mine of each type to detonate sympathetically.	feet
SYMDIF(5,7)		An array containing the maximum distances at which each indirect fire weapon type can cause a mine of each type to detonate sympathetically.	feet
SYMDIS(7,7)		An array containing the maximum distances at which each mine type can cause a mine of each type to sympathetically detonate.	feet
SYMMAX(3)		An array containing the maximum distances at which mines may be sympathetically detonated by other mines, direct fire weapons and indirect fire weapons.	feet
TADJ		An adjustment made to TIMEMV(100) to correct the target travel time at the beginning of each travel path segment.	minutes

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
TARHT(5)	H_T	An array containing the height of the intruder targets by type.	feet
TARL(5)	L_T	An array containing the length of the intruder targets by type.	feet
TARRAD(5)	R_T	An array containing the radius of the intruder targets by type.	feet
TARW(5)		An array containing the width of the intruder targets by type.	feet
TDBIFV(10)		An array containing the time delay between the volleys fired at each aimpoint.	minutes
TGTD		The time the target was delayed due to the removal of a travel path blockage.	minutes
TGTDEL(100)		An array containing the times each target was delayed due to the removal of a travel path blockage.	minutes
TGTOVL		The normal speed of the targets.	feet per minute
TGTSPD		The speed of the intruder targets.	feet per minute

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
TGTVEL(100)		An array containing the speed of each target.	feet per minute
TGTVL2		The sweep rate.	feet per minute
TGTVSV		Temporary storage for the target velocity.	feet per minute
TGTXOL(100)	$X_{T(j)}$	An array containing the original X coordinate for each target in the travel path coordinate system.	feet
TGTYNW(100)	$Y_{T(j)}$	An array containing the current Y coordinate of each target in the travel path coordinate system.	feet
TGTYOL(100)		An array containing the original Y coordinate of each target in the travel path coordinate system.	feet
TGTYSV		The Y coordinate of the event target at the point of closest approach to the mine.	feet
THET		THETA in radians.	radians
THETA	θ	The angle defining the direction of travel of the delivery aircraft (measured clockwise from the positive Y axis).	degrees

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
THETR	θ_R	The angle between the directed travel path segment and the positive X axis in the map coordinate system.	degrees
THRSIG(5,5)		An array containing distances beyond which the effects of indirect fire detonations are not considered for each indirect fire weapon type and each target type.	feet
TIMEMV(100)		An array containing the travel time for each target.	minutes
TM(130)		A temporary storage array for event times.	minutes
TMBRD(5)		An array containing the reload and aim times for each defender target type.	minutes
TMBRI(5)		An array containing the reload and aim times for each intruder target type.	minutes
TMDLCF		The amount of time the intruders will be delayed while deploying the line charge or fuel air explosive.	minutes
TMMV		The target travel time.	minutes
TMSWP(7)		An array containing the times required to remove or neutralize each mine type.	minutes

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
TMTOFR(130)		An array containing the times for events to occur for direct fire, indirect fire, and return fire.	minutes
TOTDEL		The sum of the time required to remove or neutralize a mine, the time the target was delayed due to the removal of a travel path blockage, and the time required to deploy line charges or fuel air explosives.	minutes
TOTSIM		The total breach time.	minutes
TOT2		An internal program variable.	none
TRAVTM		The travel time to the next event.	minutes
TT		A variable used as temporary storage of the travel time to the next event.	minutes
TTDI		The time between time-oriented events.	minutes
TVELPR		Temporary storage for the target velocity.	feet per minute
TYPRIT		Temporary storage for the target Y coordinate.	feet

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
T1		An intermediate variable used in determining the target offset due to diversion.	feet
T2		An intermediate variable used in determining the target offset due to diversion.	feet
T3		An intermediate variable used in determining the target offset due to diversion.	feet
V	V	An intermediate variable used in obtaining a normal random number.	none
VERT	T_V	The vertical dimension for the intruder or defender type.	feet
XCYCLE(7)		An array containing the total fuze cycle time (if any) for each target.	seconds
XD		The square of the distance in the X direction between the defender and intruder.	feet squared
XDIS		An intermediate target/mine distance used in determining the next event.	feet
XDMP(10,10)	$X_{RDMPI(j)}$	An array containing the X coordinate in the map coordinate system of the desired mean points of impact of each round	feet

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
		delivered at each indirect fire volley aimpoint.	
XFIX	X_{TO}	The target offset distance while diverting around a damaged target.	feet
XFIX1		Temporary storage for XFIX.	feet
XLCF(100)		An array containing the X coordinate of the intruder employing fuel air explosives or line charges as sweeping devices.	feet
XLOC		Temporary storage for the X coordinate of the position of the line charge or fuel air explosive.	feet
XMAX		The maximum X coordinate for mines retained for the case.	feet
XMIN		The minimum X coordinate for mines retained for the case.	feet
XODEF(20)	$X_{D(k)}$	An array containing the X coordinate of each defender in the map coordinate system.	feet
XORGVP		An internal program variable.	feet
XOVP(10)	$XO_{VAP(i)}$	An array containing the X coordinate of the origin of each volley aimpoint.	feet

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
XR		An internal program variable.	none
XRDFO(30)		An array containing the X coordinates of the ends of the direct fire attack areas.	feet
XRG(52)		An array containing the maximum value of each distribution output variable.	none
XRN		The reciprocal of the iteration number.	none
XROAD(11)	X_{R1}	An array containing the X coordinates of the ends of the travel path segments in the map coordinate system.	feet
XR1		The X coordinate of the starting point of a travel path segment.	feet
XR2		The X coordinate of the end point of a travel path segment.	feet
XSWATH(50)		An array containing mine pattern widths for uniform distributions of mines for each aimpoint.	feet
XT		The X coordinate of the intruder.	feet
XW		The X coordinate of the volley aimpoint.	feet

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
XWIDTH		The width of the area through which the targets are passing.	feet
XW2		One-half of the width of the area through which the targets are passing.	feet
XYMS(4)		An array containing the X and Y coordinates of an area of a travel path segment accessible to direct fire.	feet
YD		The square of the distance in the Y direction between the defender and intruder.	feet squared
YDIST		The distance from the Y coordinate of the position of the line charge or fuel air explosive to the outer limit of the explosive effects.	feet
YDIV(100)	Y_{DIV}	An array containing the Y coordinates of damaged targets which must be diverted around.	feet
YDMP(10,10)	$Y_{RDMPI(j)}$	An array containing the Y coordinate in the map coordinate system of the desired mean points of impact of each round delivered at each indirect fire volley aimpoint.	feet

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL (CONTINUED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
YFIX		The distance that targets are moved to reassociate with a new lead target.	feet
YLENGTH		The length of the area through which the targets are passing.	feet
YLENTH		The length of the travel path segment.	feet
YL2		One-half of the length of the area through which the targets are passing.	feet
YMAX		The maximum Y coordinate of the mines which sympathetically detonate.	feet
YMIN		The minimum Y coordinate of the mines which sympathetically detonate.	feet
YODEF(20)	$Y_{D(k)}$	An array containing the Y coordinate of each defender in the map coordinate system.	feet
YORGVP		An internal program variable.	feet
YOVP(10)	$YO_{VAP(i)}$	An array containing the Y coordinates in the map coordinate system of the origin of each volley aimpoint.	feet
YRDFO(30)		An array containing the Y coordinate in the map coordinate system of the ends of the direct fire attack areas.	feet

LIST OF SYMBOLS AND ABBREVIATIONS - SIMULATION MODEL
(CONCLUDED)

SYMBOL OR ABBREVIATION	EQUIVALENT IN MATH MODEL	DEFINITION	UNITS
YROAD(11)	Y_{R1}	An array containing the Y coordinates of the ends of the travel path segments in the map coordinate system.	feet
YR1		The Y coordinate of the starting point of a travel path segment.	feet
YR2		The Y coordinate of the end point of a travel path segment.	feet
YST		The Y coordinate of the inner limit of the fuel air explosive effects.	feet
YSWATH(50)		An array containing the mine pattern lengths for uniform distributions of mines for each aimpoint.	feet
YT		The Y coordinate of the intruder.	feet
YW		The Y coordinate of the volley aimpoint.	feet

SECTION I

INTRODUCTION

This computer simulation model, referred to as SEMAC, provides the methodology and analytical techniques required for evaluating the synergistic effects of minefields and covering fire. The program was designed to allow mixed minefields, various armored vehicle tactics, and employment of combinations of different types of direct and indirect fire. SEMAC determines, on a time history basis, the damage and the breach times for the engagement area consisting of mines and covering fire. The intruder force travels along multisegmented travel paths through the engagement area, with one of two tactics employed by the formation of targets. These tactic options are:

- The targets traverse the engagement area with no sweeping and no evasive action taken.
- The engagement area is swept by selected targets traversing the engagement area.

SEMAC is an event-oriented simulation model which uses Monte Carlo techniques to obtain measures of effectiveness. The minefield is defined by randomly applying aiming errors to each sortie and ballistic errors to each mine in the sortie. The aiming range and deflection errors are independent of each sortie of mines delivered, and the ballistic range and deflection errors are independent of each mine in the pattern. The formation of targets proceeds through the minefield, and damage is assessed for every encounter of a mine by a target. A mine which detonates is evaluated against all targets. Inputs specify the locations of covering fire weapons, their time of commencing fire, and other items pertaining to weapon employment, target acquisition, system accuracies, and return fire parameters. The effect of the covering fire on the targets attempting the minefield breach is evaluated in time sequence. The simulation ends when all targets have either passed through the minefield and/or all targets have been damaged. The minefield is redefined using random aiming and ballistic errors, and another iteration is evaluated. At the end of a selected number of iterations, statistical output is computed and presented.

The targets which are engaged in the minefield breach attempt are capable of utilizing several tactics for minesweeping. Visual detection of mines by selected target elements is provided. In addition, methodology for the employment of armored plows and rollers, explosive line charges, and fuel air explosives (FAE) is incorporated. Explosive line charges and FAE mine clearing provides minefield degradation within a rectangular area around line charges and within a circular area around FAE.

The "in minefield" targets receive direct and indirect covering fire from defending forces according to an input time schedule, and are capable of returning fire. The indirect fire methodology is based upon the development of Tri-Service approved methodology for the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME) Methodology Working Group. These techniques are used to compute the effectiveness of single or multiple releases of unguided weapons (including cluster munitions) against various types of targets. Up to ten volley aimpoints are permitted with up to ten rounds fired per volley. The effectiveness index can be expressed in the following terms:

- Mean area of effectiveness for fragmentation (MAE_f)
- Vulnerable area (VA_N)
- Mean area of effectiveness for blast (MAE_b)
- Effective miss distance (EMD).

The direct covering fire methodology considers the effects of terrain masking on target acquisition and line of fire. The extent of terrain masking is described by inputs pertaining to location and size of natural obstacles. A direct fire area is a portion of the travel path not masked by terrain.

SEMAC will simulate the passage of up to 100 intruder targets of up to five different types passing through an engagement area. The program can consider up to 50 aimpoints for mines and up to seven different mine types. A maximum of 32,767 mines can be dispensed, and up to 4,998 mines can be located within the range of influence on either side of a travel path segment. The width of the range of influence is the maximum distance at which a mine can detonate or be detected by a target. (A mine which is outside this region cannot affect the outcome of the simulation.) The computer program can evaluate the effectiveness of up to 20 defenders of up to five direct fire defender weapon types. Each of the five defender weapon types is capable of direct covering fire against the five target types of the intruder and each of the five target types of the intruder is capable of return fire against the target types of the defender.

This volume contains:

- A detailed description of the mathematical model which was used as a basis in developing SEMAC.
- A complete set of flowcharts depicting the logic used in the program.
- A complete FORTRAN IV source listing of the program.
- A detailed description of the simulation coding which is employed in the program.
- Listings of the symbols and abbreviations which are used in the mathematical model and the computer program.

Detailed descriptions of the input variables required to properly execute SEMAC, instructions for placing the input variables on punch cards and for arranging the punch cards in proper order, descriptions and definitions of the output available from SEMAC, and a description of a sample case are contained in Volume I, the User's Manual, of this report.

SECTION II

MATHEMATICAL MODEL

The mathematical model for SEMAC is separated into three principal parts, which are:

- Computation of effectiveness of mines.
- Computation of effectiveness of direct fire munitions.
- Computation of effectiveness of indirect fire munitions.

These principal parts of the mathematical model are discussed in detail in the following paragraphs.

COMPUTATION OF EFFECTIVENESS OF MINES

The mathematical model for SEMAC provides for up to 100 intruders of up to five different types passing through the engagement area. Up to 50 aimpoints and up to seven different mine types can be considered. A maximum of 32,767 mines can be dispensed, and up to 4,998 mines can be located within the range of influence on either side of a travel path segment. The width of the range of influence is the maximum distance at which a mine can detonate or be detected by an intruder. (A mine which is outside this region cannot affect the outcome of the simulation.)

Computation of Mine Locations in Map Coordinate System

At the start of each iteration, the mine impact points are computed. First, the mine locations for each sortie and sortie aimpoint, including aiming and ballistic errors, are computed using the expressions:

$$X'_{M(i)} = D_{MPI(i)} + R_{N1}(\sigma_{AD}) + R_{N3}(\sigma_{BD}) \qquad (1)$$

$$Y'_{M(i)} = R_{MPI(i)} + R_{N2}(\sigma_{AR}) + R_{N4}(\sigma_{BR}) \qquad (2)$$

where $X'_{M(i)}$ and $Y'_{M(i)}$ are the X and Y coordinates of the ith mine with respect to the nominal sortie aimpoint, $D_{MPI(i)}$ and $R_{MPI(i)}$ are the deflection and range components of the mean point of impact computed in SEMAC by one of the five methods shown in Table 1, R_{N1}, R_{N2}, R_{N3}, and R_{N4} are normally distributed random numbers, σ_{AR} and σ_{AD} are the standard deviations in range and deflection describing the distribution of the aiming error, and σ_{BR} and σ_{BD} are the standard deviations in range and deflection describing the distribution of the ballistic error. In determining the values of $D_{MPI(i)}$ and $R_{MPI(i)}$, uniformly distributed mines are bounded by the input values of X_S (the maximum width of the pattern) and Y_S (the maximum length of the pattern). Normal distributions of mines are also determined using X_S and Y_S; however, for this option, the input values of X_S and Y_S are six standard deviations, and X_S and Y_S are divided by the value 6 to obtain the standard deviations in deflection and range describing the pattern.

To determine R_{N1}, R_{N2}, R_{N3}, and R_{N4}, a uniform random number (U_{RN}) is generated using RANF (a Control Data Corporation library function), and the following polynomial equations are evaluated to convert U_{RN} to a corresponding random number from a normal distribution.

$$V = \sqrt{(-2)\ln\{0.5[1.0 - (|1.0 - 2.0(U_{RN})|)]\}} \qquad (3)$$

$$R_N = V - \frac{(2.515517 + 0.802853V + 0.010328V^2)}{(1 + 1.432788V + 0.189269V^2 + 0.0013208V^3)} \qquad (4)$$

where R_N is the normal random number, and U_{RN} is a random number from a uniform distribution. The value of R_N is positive if $0.5<U_{RN}<1.0$ and negative if $0 \le U_{RN} \le 0.5$.

Next, the mine coordinates [i.e., the $X'_{M(i)}$ and $Y'_{M(i)}$ values] are transformed into the map coordinate system using the expressions (see Figure 1):

$$X_{M(i)} = X_{A(n)} + X'_{M(i)}\cos\theta + Y'_{M(i)}\sin\theta \qquad (5)$$

$$Y_{M(i)} = Y_{A(n)} - X'_{M(i)}\sin\theta + Y'_{M(i)}\cos\theta \qquad (6)$$

TABLE 1. DETERMINATION OF RANGE AND DEFLECTION COORDINATES OF MEAN POINT OF IMPACT

OPTION	$R_{MPI(i)}$	$D_{MPI(i)}$
0	Read in from input data	Read in from input data
1	Select from random normal distribution	Select from random normal distribution
2	Select from random uniform distribution	Select from random uniform distribution
3	Select from random normal distribution	Select from random uniform distribution
4	Select from random uniform distribution	Select from random normal distribution

where $X_{M(i)}$ and $Y_{M(i)}$ are the X and Y coordinates of the ith mine in the map coordinate system, $X'_{M(i)}$ and $Y'_{M(i)}$ are as described above, $X_{A(n)}$ and $Y_{A(n)}$ are the X and Y coordinates of the nth sortie aimpoint with which the ith mine is associated, and θ is the azimuth angle defining the direction of travel of the delivery aircraft (measured clockwise from the positive Y axis).

To evaluate the effects of weapon reliability, a uniform random number (U_{RN}) is selected for each mine, and this number is compared to the input value of the probability that the mine is a dud (P_{DUD}). If the inequality:

$$U_{RN} < P_{DUD} \tag{7}$$

is satisfied and if Tactic 1 is being employed, the mine is considered a dud and is eliminated from further consideration.

Transformation of Mine Locations Into Travel Path Coordinate System and Initial Placement of Targets

In order to evaluate large numbers of mines, the target formation traverses each input path segment one at a time with the following restrictions.

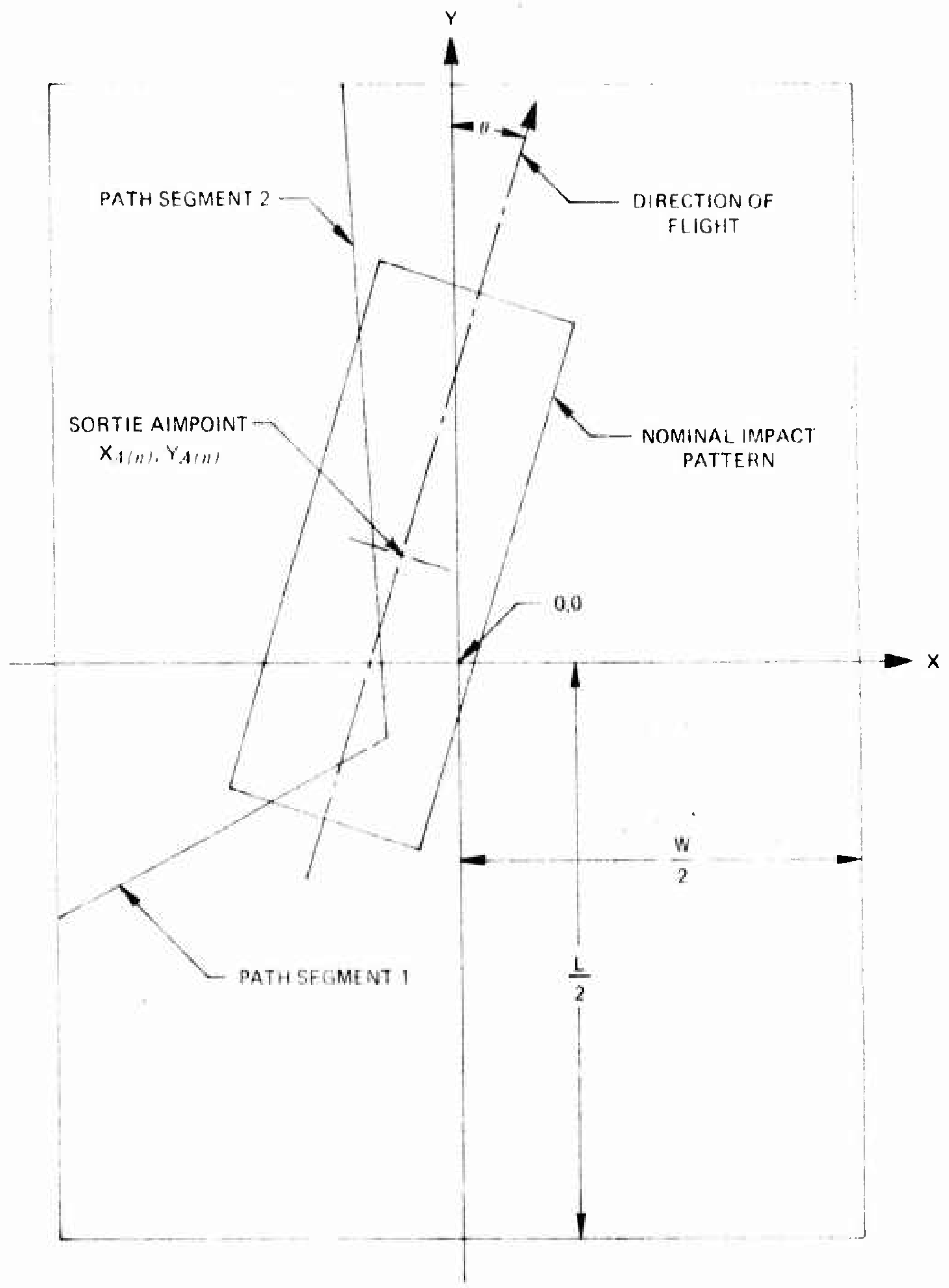


Figure 1. Map Coordinate System

- Each path segment must be less than 6,553 feet in length.
- The maximum number of mines within range of influence of any target for a path segment is limited to 4,998.
- The maximum number of mines which are permitted to fall within the width of the target area rectangle (W) and the length of the target area rectangle (L) is 32,767.
- Only those mines which are within 1,638 feet on either side of the nominal centerline of the path segment are considered. (Only those mines within the range of influence of a target are saved.)
- For mines with a timing cycle, the total of ON and OFF time for a single cycle must be less than 256 seconds.

The travel path coordinate system is defined with the origin at the path segment starting point; the positive Y axis defines the direction of travel, and the positive X axis is to the right. The mine locations are transformed into the path coordinate system using the expressions (see Figure 2):

$$X_{MR(i)} = [X_{M(i)} - X_{R1}]\cos\theta_R + [Y_{M(i)} - Y_{R1}]\sin\theta_R \qquad (8)$$

$$Y_{MR(i)} = -[X_{M(i)} - X_{R1}]\sin\theta_R + [Y_{M(i)} - Y_{R1}]\cos\theta_R \qquad (9)$$

where $X_{MR(i)}$ and $Y_{MR(i)}$ are the X and Y coordinates of the ith mine in the path coordinate system, $X_{M(i)}$ and $Y_{M(i)}$ are as described above, X_{R1} and Y_{R1} are the X and Y coordinates of the path segment starting point in the map coordinate system, and θ_R is the computed angle between the X and X_R axes.

After the coordinates of a mine are computed as described above, the model determines if the mine is within the range of influence. A mine is outside this range of influence and is eliminated from further consideration if its distance to the travel path is so large that both of the following conditions exist.

- The probability that the sweeping element will detect the mine is zero.

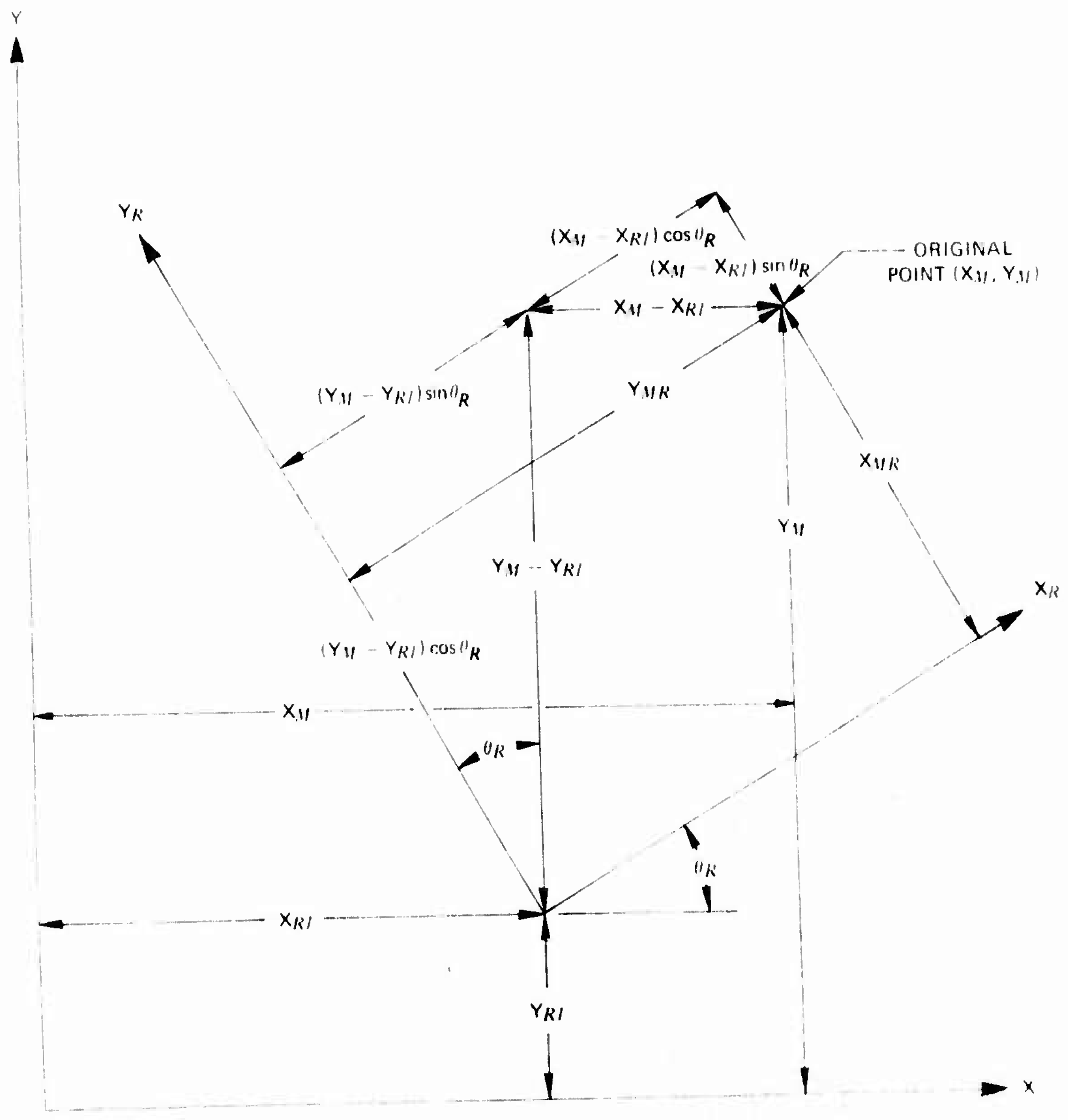

Y
Y_R
$(X_M - X_{RI})\cos\theta_R$
$(X_M - X_{RI})\sin\theta_R$
ORIGINAL POINT (X_M, Y_M)
$X_M - X_{RI}$
$(Y_M - Y_{RI})\sin\theta_R$
Y_{MR}
X_{MR}
Y_M
$Y_M - Y_{RI}$
X_R
$(Y_M - Y_{RI})\cos\theta_R$
X_M
θ_R
θ_R
X_{RI}
Y_{RI}
X

Figure 2. Transformation of Mine Locations From Map Coordinate System Into Travel Path Coordinate System

- The probability that the mine will detonate is zero.

A mine is also eliminated from further consideration for the path segment if its Y_{MR} coordinate is less than zero or greater than the length of the path segment. [A mine can conceivably be within the range of influence and within the path segment length for more than one path segment. Such a mine, if detonated while the targets are traversing one path segment, cannot be detonated while the targets are traversing a subsequent segment. To account for this situation, a binary switch is maintained (one bit for each mine) to ensure that a detonated mine is not included in a subsequent path segment.]

For mines controlled by an ON/OFF timing cycle, a random starting time for each mine is computed using the expression:

$$t_s = U_{RN}(t_{on} + t_{off}) \tag{10}$$

where t_s is the random starting point for the fuze timing cycle, U_{RN} is a uniform random number, t_{on} is the duration of the active portion of the fuze timing cycle, and t_{off} is the duration of the inactive portion of the fuze timing cycle.

For each mine on a path segment, the mine information described above is packed into a 60-bit CDC 6600 word in the following manner.

```
0yyyyyyyyyyyyyyyysxxxxxxxxxxxxxiiiiiiiitttttmmmmmmmmmmmmmmmm
```

The meaning of each bit position is described in Table 2.

Since each component of the vector containing the packed mine information looks like a positive integer, the vector can be sorted into ascending order, thereby ordering the vector by increasing mine Y coordinate. The sorting technique utilized was developed by Mr. Richard Singleton under a Stanford Research Institute project. Details pertaining to this sorting technique can be found in Algorithm 347 of <u>Collected Algorithms from Communications of the Association for Computing Machinery</u>.

Initial positions of the targets are specified as inputs, with the first target input assuming a position on the path segment centerline and at the path segment starting point (i.e., the origin of the path coordinate system). All other

TABLE 2. BIT LOCATIONS FOR PACKED EVENT INFORMATION

BIT	LETTER CODE	DESCRIPTION
59	0	Always zero to create a word which looks like a positive integer.
58 through 43	y	Sixteen bits containing the event Y coordinate $[Y_{MR(i)}]$ times 10.
42	s	The sign of the event X coordinate $[X_{MR(i)}]$.
41 through 28	x	Fourteen bits containing the magnitude of the event X coordinate $\|X_{MR(i)}\|$ times 10.
27 through 20	i	Eight bits containing the mine random starting time (t_s), if any, or the direct fire area number.
19 through 15	t	Five bits containing the event type (see NOBTP2 in the List of Symbols and Abbreviations - Simulation Model).
14 through 0	m	Fifteen bits containing the sequential mine number or the indirect fire volley aimpoint.

targets are placed at positions relative to the first as defined by their input [i.e., $X_{T(j)}$ and $Y_{T(j)}$] locations. All of the targets travel along the path in formation; when all of the targets have either completed traversing the first path segment or have been damaged, the undamaged targets are placed in a similar manner at the start of the next path segment (if any). The formation of targets is maintained rather than closing up any gaps left by damaged targets.

Determination of Next Event

A simplified method is employed for determining the next event which will occur. The vector containing the packed event information has been sorted by ascending Y coordinate so that the next event can be determined by incrementing a counter. If the i^{th} event is the next one to be encountered by the j^{th} target, the expression used to determine the range distance that must be traveled by the target to reach the point of closest approach to the event $[\Delta Y_{(ij)}]$ is:

$$\Delta Y_{(ij)} = |Y_{MR(i)} - Y_{T(j)}| \qquad (11)$$

where $Y_{T(j)}$ is the Y coordinate of the jth target and $Y_{MR(i)}$ is as defined above. The smallest $\Delta Y_{(ij)}$ is determined and the time required for the target associated with the event to travel this distance is computed. If the event target is not involved in a delay condition, the associated target/event combination constitutes the next position oriented event. Before this target is involved in the next event, the time oriented events are considered. All time ordered events that will occur in less time than the travel time to the next event are considered before the event target is moved the distance $\Delta Y_{(ij)}$.

Evaluation of Target/Mine and Target/Boundary Interactions

At this point in the execution of an event, the event target and the event mine have the same Y coordinate (i.e., the target is at its point of closest approach to the mine). The lateral distance between the target and the mine $[\Delta X_{(ij)}]$ is computed using the expression:

$$\Delta X_{(ij)} = X_{MR(i)} - X_{T(j)} \qquad (12)$$

where $X_{T(j)}$ is the X coordinate of the jth target, and the other variables are as defined above.

When some targets are damaged, subsequent targets in the same column must divert around the damaged target. If a target is within 60 feet of a damaged target and must divert around the damaged target, Equation (12) is modified to reflect the diversion geometry (see Figure 3). The target offset is computed using the expression:

$$X_{TO} = \sqrt{(75)^2 - [Y_{T(j)} - Y_{DIV}]^2} - 45 \qquad (13)$$

where X_{TO} is the magnitude of the target offset while diverting around the damaged target, $Y_{T(j)}$ is as defined above,

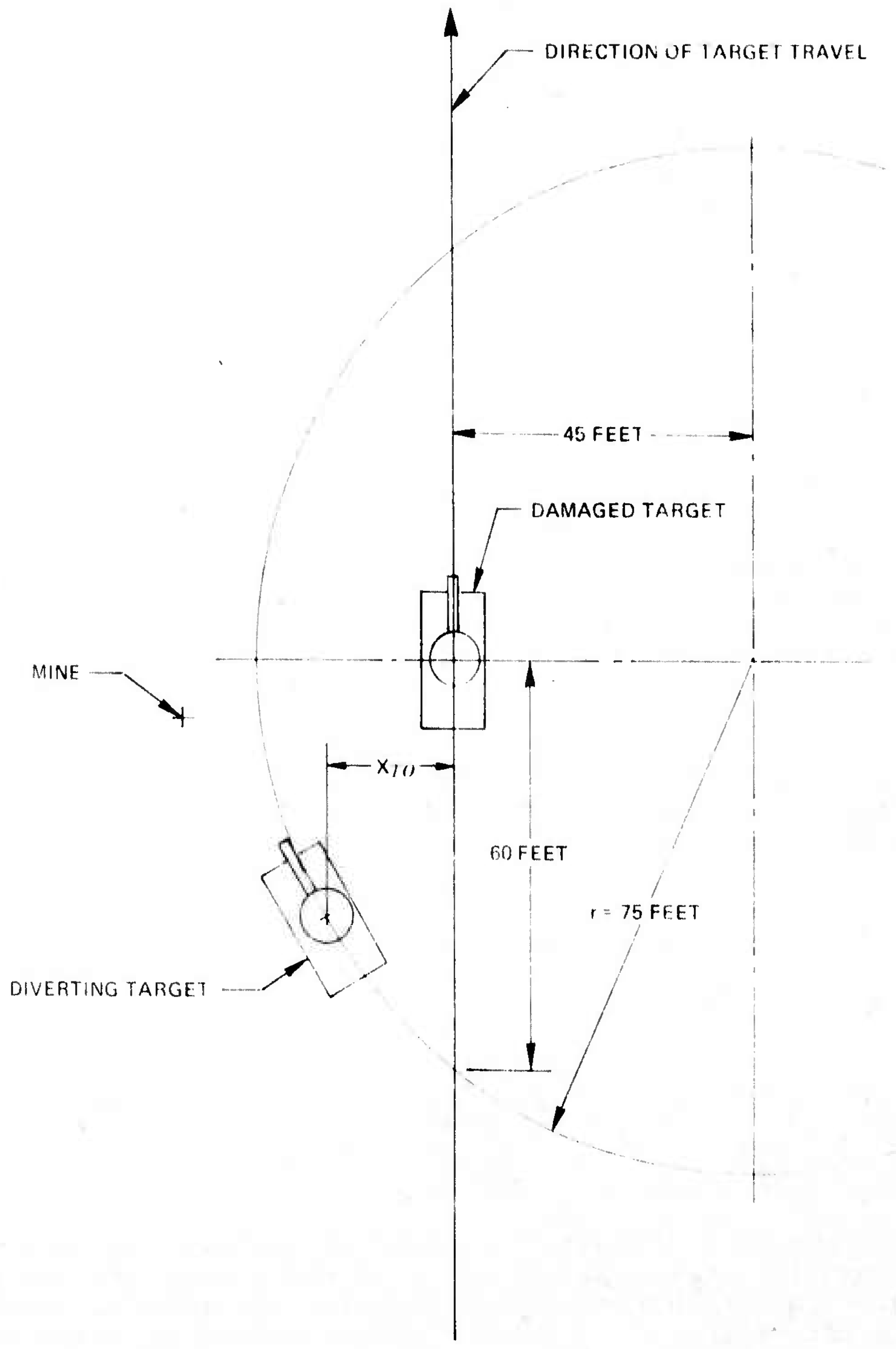


Figure 3. Geometry of Target Diversion

Y_{DIV} is the Y coordinate of the damaged target, the quantity 75 is the radius of the diversion circle in feet, and the quantity 45 is the distance in feet from the center of the diversion circle to the nominal travel path.

When the event target is diverting around a damaged target while at the point of closest approach to the event mine, the lateral distance between the target and the mine $[\Delta X_{(ij)}]$ is computed using the expression:

$$\Delta X_{(ij)} = |X_{MR(i)} - X_{T(j)} - X_{TO}| \qquad (14)$$

where all variables are as defined above. If a diverting target is damaged by a mine while traveling on the diversion circle and the diverting target must itself be diverted around, subsequent targets are diverted in the opposite direction, causing a change in the sign of X_{TO}. If two targets which must be diverted around are damaged, one while diverting left and one while diverting right, a time delay is assessed for remaining targets in the column to provide for removal of the three damaged targets.

A standard linear interpolation technique is used to provide for the computation of probabilities of mine detection (sweeping), mine detonation, and target damage. The expression used to perform the linear interpolation is:

$$P = P_q + \frac{[\Delta X_{(ij)} - R_q][P_{q+1} - P_q]}{(R_{q+1} - R_q)} \qquad (15)$$

where P is the interpolated probability, $\Delta X_{(ij)}$ is the lateral distance between the target and the mine, R_q and R_{q+1} are ranges from the tabular input of the function being interpolated such that $R_q \leq \Delta X_{(ij)} < R_{q+1}$, and P_q and P_{q+1} are probabilities corresponding to R_q and R_{q+1}.

If the event target is capable of sweeping the event mine, Equation (15) is evaluated utilizing the appropriate sweeping function to obtain the probability that the mine is detected by the target (P_{dt}). A uniform random number is selected and compared to the value of P_{dt}. If the random number is less than the value of P_{dt}, the mine is detected and neutralized by the target, and the event is completed.

If the mine is not detected, the model next determines whether the mine detonates. If the mine employs a fuze timing device, SEMAC determines if the fuze is active at the time that the target reaches the point of closest approach. To accomplish this, the number of times that the fuze has completed its timing cycle during the simulation is determined using the expression:

$$N_t = \frac{t_r - t_s}{t_{on} + t_{off}} \qquad (16)$$

where N_t is the number of complete fuze cycles (truncated to an integer number), t_r is the time period used in the simulation to the specific point in time when the event occurs, t_s is the random starting point for the fuze timing cycle (which must be smaller than the total fuze cycle time), and t_{on} and t_{off} are as defined above.

To determine whether the fuze is active at the time the event occurs, the following expression is evaluated.

$$T_t = t_r - N_t(t_{on} + t_{off}) \qquad (17)$$

where t_r, N_t, t_{on}, and t_{off} are as defined above, and T_t is a time period relating to the fuze timing cycle. If the value of T_t is less than the time that the fuze is active, the mine is considered active and can detonate.

Equation (15) is evaluated utilizing the appropriate detonation function to obtain the probability that the mine will detonate (P_{dn}). A uniform random number is selected and compared to the value of P_{dn}. If the random number is less than the value of P_{dn}, the mine is detonated.

The effect of a mine which detonates is evaluated against all targets which are close enough to be damaged by the mine. The distance from the mine to each target (D_{MT}) is determined using the expression:

$$D_{MT} = \sqrt{[X_{MR(i)} - X_{T(j)} - X_{TO}]^2 + [Y_{MR(i)} - Y_{T(j)}]^2} \qquad (18)$$

where all variables are as defined above. Substituting D_{MT} for $\Delta X_{(ij)}$, Equation (15) is evaluated utilizing the appropriate damage function to obtain the probability that the target is damaged (P_d). A uniform random number is selected and compared to the value of P_d. If the random number is less than the value of P_d, the target is considered damaged.

SEMAC permits targets to be associated with a lead target as a group or unit (e.g., troops on foot following a tank). If a lead target is damaged, three options are available for determining the disposition of its associated targets. The first choice is to proceed in the original direction if another target of the same type as the damaged target is in front of the associated targets in the column. If the first choice is not available, the associated targets can wait for a following lead target in the same column to reach their position and fall in behind it. If neither of the first two options is available, it is assumed that the associated targets will return back the path that they were traveling and will not attempt to breach the minefield again. These targets are assumed to be lost to the current mission and are so reported, but they are not included in the damaged target count.

One other type of interaction which is included in SEMAC and which results in degradation of the minefield is termed sympathetic detonations. Sympathetic detonations can occur if the disturbance caused by a detonating mine or exploding munition is capable of detonating nearby mines. If the sympathetic detonation options are chosen, the maximum range at which a detonating mine or exploding direct or indirect fire munition is input. When a mine detonates or a direct or indirect fire munition explodes, the mines within the maximum distance in the Y direction are identified; then, the distance to each of those mines is determined individually using the expression:

$$D_{(ik)} = \sqrt{[X_{MR(k)} - X_{MR(i)}]^2 + [Y_{MR(k)} - Y_{MR(i)}]^2} \qquad (19)$$

where $D_{(ik)}$ is the distance from the ith (detonating mine or exploding munition) to the kth mine, and the X_{MR} and Y_{MR} are the mine coordinates. If $D_{(ik)}$ is less than the distance at which the ith mine or exploding munition can sympathetically detonate the kth mine, the kth mine detonates.

Minesweeping Techniques

The intruding forces may employ the following types of minesweeping techniques:

- Visual sweeping.
- Plows and rollers.
- Fuel-air-explosives (FAE).
- Line charges.

Visual sweeping of the mines is accomplished as the intruders traverse the minefield. As the mines are detected, the mines are either removed or detonated. Rollers and plows are modeled as separate target types located a fixed distance in front of another target. The range dependent probability functions of detonation and damage are input to the computer program. A nonunity probability of encounter for a roller is used to model the roller bouncing over a mine. For a plowed mine, the probability that the mine will still function is input. The target type employing the FAE or line charges is input in addition to the pattern effects dimensions. The pattern produced by the FAE is circular and is computed using the following expressions:

$$Y_{PC(i)} = Y_{T(j)} + D_F \tag{20}$$

$$Y_{PO(i)} = Y_{PC(i)} + R_F \tag{21}$$

$$Y_{PI(i)} = Y_{PC(i)} - R_F \tag{22}$$

where $Y_{PC(i)}$ is the center of the pattern, $Y_{T(j)}$ is the Y coordinate of the jth target, D_F is the distance in front of the target where the FAE detonates, $Y_{PO(i)}$ is the furthest point from the target of the FAE effects, R_F is the radius of the FAE effects, and $Y_{PI(i)}$ is the closest point to the target of the FAE effects. If a mine is located within the pattern of the FAE effects, a uniform random number (U_{RN}) is selected, and this number is compared to the input value of the probability of mine detonation within the FAE pattern (P_{DF}). If the inequality:

$$U_{RN} < P_{DF} \tag{23}$$

is satisfied, the mine is eliminated from further consideration.

For line charges, the pattern is considered to be rectangular and originates just in front of the intruder which deploys the device. The line charge effects are L_{LC} in length and W_{LC} in width. If a mine is located within the pattern of the line charge effects, a uniform random number (U_{RN}) is selected and compared to the input value of the probability of mine detonation within the line charge pattern (P_{DF}). Inequality (23) is evaluated, and if the inequality is satisfied, the mine is eliminated from further consideration.

The locations for FAE or line charge deployment are determined at the beginning of each travel path segment and it is assumed that sufficient devices are available to sweep across the minefield. The line charge effect is continuous in that when the effective length of one line charge detonation is reached, another line charge is deployed. This is not so for FAE sweeping devices because the area of effectiveness is circular and they are deployed a specified distance in front of the intruding target. The deployment positions along the travel path segment are assigned the X coordinate of the intruder which deploys the devices and the information is packed into a computer word just like the mine information, except that the variable NOBTP2 is set to 19 for each deployment position.

COMPUTATION OF EFFECTIVENESS OF DIRECT FIRE MUNITIONS

SEMAC contains methodology for determining the effectiveness of direct fire munitions employed by the defending forces and return fire by the intruders. The program can consider up to 20 defenders of up to five different types firing into portions of the engagement area not protected by terrain shielding.

Discussion of Direct Fire Logic

For the purposes of this discussion, direct fire is defined as surface-to-surface munition deployment when the attacking element weapon system can "see" the unitary target either visually or with electronic aid.

SEMAC models the effects of terrain shielding by allowing the user to define portions of the engagement area into which direct fire can be achieved. A defender is defined to be at some particular X, Y coordinate in the engagement area and may shoot into some or all of the direct fire areas. The portion of the engagement area into which a defender cannot shoot (and from which the defender cannot receive return fire) is considered to be shielded by terrain features.

Whereas intruder/mine encounters are position (or distance) related, the logic for direct and return fire is time ordered once an intruder enters a direct fire area. Priority lists defining the order in which a defender type will shoot at the various intruder types (and vice versa) is provided for the case. In addition, the direct fire areas into which each defender can shoot (and receive return fire) are provided. When an intruder of a type on a defenders priority list enters a direct fire area into which that defender can shoot, the defender fires and the results are evaluated. That defender cannot fire again until the time to reload and aim has elapsed. Although the defender was prepared to fire into one of the direct fire areas as soon as an intruder on the priority list was observed, the intruder may not immediately be prepared to return fire. In addition, the intruder may require some time to find the defender in order to return the fire. This situation is modeled in SEMAC by requiring that an intruder (by type) observe a specified number of rounds before beginning return fire.

SEMAC handles the combination of distance related and time ordered events in the following manner. Subroutine LOOPS determines what the next distance related event is to be. This can be an intruder encountering a mine, a travel path segment boundary, a line charge or fuel air explosive deployment location, a direct fire area entrance or exit boundary, or the point at which the first volley is fired at an indirect fire volley aimpoint. Before the distance related event takes place, the possible time ordered events are checked to determine if one or more should occur first. The possible time ordered events are direct fire shots, return fire shots, or the delivery of the second or subsequent volley at an indirect fire volley aimpoint. If one or more time ordered events should occur before the intruders get to the distance related event, the intruders are moved to the location at which each time ordered event is to take place, and the event results are evaluated. Finally, when all of the required time ordered events have occurred, the intruders are moved the remaining distance and the event determined by Subroutine LOOPS is evaluated. This logic is included in Subroutine CKEVTM.

Transformation of Direct Fire Area Boundaries Into Travel Path Coordinate System

The entrance and exit boundary coordinates of the direct fire areas are input in the map coordinate system on, or adjacent to, the appropriate travel path segment. The Y coordinate of the direct fire area entrance or exit boundary $[Y_{DR(i)}]$ in the travel path coordinate system is computed by the expression:

$$Y_{DR(i)} = -[X_{D(i)} - X_{R1}]\sin\theta_R + [Y_{D(i)} - Y_{R1}]\cos\theta_R \quad (24)$$

where $X_{D(i)}$ and $Y_{D(i)}$ are the X and Y coordinates of the ith entrance or exit boundary in the map coordinate system, X_{R1} and Y_{R1} are the X and Y coordinates of the travel path segment starting point in the map coordinate system, and θ_R is the computed angle between the X and X_R axes (see Figure 2). The transformed X coordinate is not required.

The transformed direct fire area entrance and exit boundaries are packed into a computer word just like the mine information, except that the variable NOBTP2 is set to 17 for entrance boundaries and 18 for exit boundaries.

Direct Fire Effectiveness Computations

When, during the evaluation of time ordered events, a defender is to fire on an intruder or vice versa, Subroutine DIRFIR is called to perform the computations. Two types of effectiveness indices are permitted, which are:

- Mean area of effectiveness for fragmentation (MAE_f) in the ground plane in square feet.

- Probability of damage given a hit (P_{HD}).

When MAE_f is specified, it is assumed that the round will arrive with a nonzero impact angle, such that the round will impact on the target or near the target on the ground. The P_{HD} option can be used to model the situation where the weapon may go past the target and detonate harmlessly some distance away.

If the effectiveness index type is MAE_f, the weapon length-to-width ratio (a) is computed using the expression:

$$a = 1 - 0.8[\cos(I)] \qquad (25)$$

where I is the impact angle. The effective target length (L_{ET}) and the effective target width (W_{ET}) are computed using the expressions:

$$L_{ET} = 2\sqrt{\frac{(MAE_f)(a)}{\pi}} \qquad (26)$$

$$W_{ET} = \frac{L_{ET}}{a} \qquad (27)$$

The range single shot probability of hit (RSSP) and the deflection single shot probability of hit (DSSP) are computed by the expressions:

$$RSSP = \frac{L_{ET}}{\sqrt{17.6(REP)^2 + (L_{ET})^2}} \qquad (28)$$

$$DSSP = \frac{W_{ET}}{\sqrt{17.6(DEP)^2 + (W_{ET})^2}} \qquad (29)$$

where REP and DEP are the range error probable and the deflection error probable in the ground plane. Finally, the single shot probability of damage (SSP_D) is computed by the expression:

$$SSP_D = RSSP(DSSP)(R) \qquad (30)$$

where R is the reliability of the round.

If the effectiveness index is in terms of P_{HD}, the circular error probable in the normal plane (CEP) can be input in feet or mils. When CEP is in mils, it is converted to feet by the expression:

$$CEP = \frac{CEP_{mils}}{1000}\left[\sqrt{[X_{T(j)} - X_{D(k)}]^2 + [Y_{T(j)} - Y_{D(k)}]^2}\right] \quad (31)$$

where $X_{T(j)}$ and $Y_{T(j)}$ are the coordinates of the intruder, and $X_{D(k)}$ and $Y_{D(k)}$ are the coordinates of the defender. The target, whether intruder or defender, is attacked with consideration being given to its presented dimensions in the vertical and horizontal directions. The vertical dimension is target height, whereas the horizontal dimension is either twice the target radius (for circular targets) or the average of target length and width (for rectangular targets). Intermediate factors a_1 and b_1 are computed by the expressions:

$$a_1 = \frac{T_H}{1.7(CEP)} \quad (32)$$

$$b_1 = \frac{T_V}{1.7(CEP)} \quad (33)$$

where T_H and T_V are the target horizontal and vertical dimension, respectively.

The single shot probability of damage is then computed by the expression:

$$SSP_D = \frac{2}{\sqrt{2\pi}}\int_0^{a_1} e^{-\frac{X^2}{2}}dx\left[\frac{2}{\sqrt{2\pi}}\int_0^{b_1} e^{-\frac{X^2}{2}}dx\right](R)(P_{HD}) \quad (34)$$

where the integrals represent the cumulative normal distribution function, and the other variables are defined above.

The SSP_D value is then compared to a random number from a uniform distribution (U_{RN}) and if the inequality:

$$U_{RN} < SSP_D \quad (35)$$

is satisfied, the target is damaged and is removed from further consideration.

COMPUTATION OF EFFECTIVENESS OF INDIRECT FIRE MUNITIONS

The indirect attack munition effectiveness methodology is derived from methodology accepted by the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME) and published in the Joint Munitions Effectiveness Manual, Air-to-Surface (JMEM/AS) Basic Manual. The methodology can assess weapon effectiveness against unitary targets. The effectiveness index can be in terms of mean area of effectiveness for fragmentation in the ground plane (MAE_f), vulnerable area in the normal plane (VA_N), mean area of effectiveness for blast in the ground plane (MAE_b), or, for effective miss distance in the ground plane (EMD). The delivery accuracy is input as range error probable (REP) and deflection error probable (DEP) in the ground plane.

The methodology assumes that the indirect fire weapons are directed by a forward observer who provides an estimated time of arrival (ETA) for the lead target at a predetermined location in the minefield. When this point is reached, the weapons each fire a specified number of volleys, with a specified delay between volleys for reloading. The first volley arrives when the lead target is at the point of closest approach to the origin of the volley pattern coordinate system, thus providing the user a degree of flexibility regarding the volley pattern coverage of the target formation for the first volley.

<u>Transformation of Indirect Fire Volley Aimpoint Locations Into Travel Path Coordinate System</u>

At the beginning of each travel path segment, the indirect fire volley aimpoint locations along the travel path segment are computed. First, the specified origins of the volley aimpoint coordinate systems are transformed into the travel path coordinate system using the expressions:

$$X_{VAP(i)} = [XO_{VAP(i)} - X_{R1}]\cos\theta_R + [YO_{VAP(i)} - Y_{R1}]\sin\theta_R \quad (36)$$

$$Y_{VAP(i)} = - [XO_{VAP(i)} - X_{R1}]\sin\theta_R + [YO_{VAP(i)} - Y_{R1}]\cos\theta_R \quad (37)$$

where $X_{VAP(i)}$ and $Y_{VAP(i)}$ are the X and Y coordinates of the ith volley aimpoint origin in the path coordinate system, $XO_{VAP(i)}$ and $YO_{VAP(i)}$ are the X and Y coordinates of the ith volley aimpoint origin in the map coordinate system, X_{R1}

and Y_{R1} are the X and Y coordinates of the path segment starting point in the map coordinate system, and θ_R is the computed angle between the X and X_R axes (see Figure 2).

After the coordinates of the volley aimpoint origins are computed as described above, the model determines if the aimpoint is within the range of target travel for this path segment. An aimpoint is eliminated if its $Y_{VAP(i)}$ coordinate is less than zero or greater than the length of the path segment, or if its $X_{VAP(i)}$ coordinate is not within 1,638 feet on either side of the nominal centerline of the path segment.

For each volley aimpoint, the X and Y coordinates, the volley aimpoint number and the intruder leading the column of intruding targets that initiates the indirect fire at this aimpoint is packed into a 60-bit CDC 6600 word. The variable NOBTP2 is set to 16 for indirect fire volley aimpoint origins.

The first volley at each aimpoint is timed to arrive when the lead target is at the point of closest approach to the origin of the volley pattern. Subsequent volleys will arrive at the aimpoint based on the amount of time required for the indirect fire weapons to reload.

The X and Y coordinates of the desired mean points of impact for each round in the volley are input with respect to the origin of the volley pattern. The expressions:

$$X_{RDMPI(j)} = XO_{VAP(i)} + X_{RDPI(j)}\cos\theta_{F(i)} + Y_{RDPI(j)}\sin\theta_{F(i)} \quad (38)$$

$$Y_{RDMPI(j)} = YO_{VAP(i)} + Y_{RDPI(j)}\cos\theta_{F(i)} - X_{RDPI(j)}\sin\theta_{F(i)} \quad (39)$$

transform the desired mean points of impact for each round in the volley, $X_{RDMPI(i)}$ and $Y_{RDMPI(i)}$, into the map coordinate system, where $XO_{VAP(i)}$ and $YO_{VAP(i)}$ are as described above, $X_{RDPI(j)}$ and $Y_{RDPI(j)}$ are the X and Y coordinates of the desired points of impact with respect to the origin of the volley pattern and $\theta_{F(i)}$ is the direction of attack for the indirect fire volley aimpoint, measured clockwise from the positive Y axis in the map coordinate system.

The desired points of impact for each round in the volley pattern are transformed into the travel path system by the expressions:

$$X_{RI(j)} = [X_{RDMPI(j)} - X_{R1}]\cos\theta_R + [Y_{RDMPI(j)} - Y_{R1}]\sin\theta_R \quad (40)$$

$$Y_{RI(j)} = [X_{RDMPI(j)} - X_{R1}]\sin\theta_R + [Y_{RDMPI(j)} - Y_{R1}]\cos\theta_R \quad (41)$$

where $X_{RDMPI(j)}$, $Y_{RDMPI(j)}$, X_{R1}, Y_{R1}, θ_R are as described above, and $Y_{RI(j)}$ and $Y_{RI(j)}$ are the transformed X and Y coordinates of the desired points of impacts for each round in the volley pattern.

Indirect Fire Effectiveness Computations

Each indirect fire volley is composed of one or more rounds detonating in the vicinity of the targets at approximately the same time. The cumulative effects of the rounds are determined for each target individually by the SEMAC methodology. Considering the i^{th} round and the j^{th} target, the components of offset, R_O and D_O, are computed by the expressions:

$$R_O = |[X_{RI(i)} - X_{T(j)}]\sin\theta_{FR} + [Y_{RI(i)} - Y_{T(j)}]\cos\theta_{FR}| \quad (42)$$

$$D_O = |- [X_{RI(i)} - X_{T(j)}]\cos\theta_{FR} + [Y_{RI(i)} - Y_{T(j)}]\sin\theta_{FR}| \quad (43)$$

where R_O is the target/round distance in the range direction, D_O is the target/round distance in the deflection direction, $X_{RI(i)}$ and $Y_{RI(i)}$ are the X and Y coordinates of the desired mean point of impact for the round, $X_{T(j)}$ and $Y_{T(j)}$ are the X and Y coordinates of the target, and θ_{FR} is the direction of attack for the volley measured in the travel path coordinate system.

If the round is an improved conventional munition (ICM), the pattern length (L_P) and width (W_P) are computed by the expression:

$$L_P = W_P = \sqrt{\pi}(R_P) \quad (44)$$

where R_P is the radius of the ICM pattern, and the probability of damage given that the target is in the pattern (P_{HD}) is computed by the expression:

$$P_{HD} = 1 - e^{-\frac{N_S(R_S)(MAE_f)}{L_P(W_P)}} \qquad (45)$$

where N_S is the number of submunitions and R_S is the reliability of the submunition. The effective target length (L_{ET}) is set to the value of L_P, and the effective target width (W_{ET}) is set to the value of W_P.

If the effectiveness index type is MAE_f, and the round is high explosive (HE), the weapon length-to-width ratio (a) is computed using the expression:

$$a = 1 = 0.8[\cos(I)] \qquad (46)$$

where I is the weapon impact angle. The effective target length (L_{ET}) and the effective target width (W_{ET}) are computed using the expressions:

$$L_{ET} = 2\sqrt{\frac{(MAE_f)(a)}{\pi}} \qquad (47)$$

$$W_{ET} = \frac{L_{ET}}{a} \qquad (48)$$

The range single shot probability of hit (RSSP) and the deflection single shot probability of hit (DSSP) are computed by the expressions:

$$RSSP = \frac{L_{ET}}{\sqrt{17.6(REP)^2 + (L_{ET})^2}}\, e^{\frac{-4(R_O)^2}{17.6(REP)^2 + (L_{ET})^2}} \qquad (49)$$

$$DSSP = \frac{W_{ET}}{\sqrt{17.6(DEP)^2 + (W_{ET})^2}}\, e^{\frac{-4(D_O)^2}{17.6(DEP)^2 + (W_{ET})^2}} \qquad (50)$$

where REP and DEP are the range error probable and the deflection error probable in the ground plane, respectively, and all other variables are as defined above. The single shot probability of damage (SSP_D) is then calculated by the expression:

$$SSP_D = RSSP(DSSP)(R)(P_{HD}) \tag{51}$$

where R is the reliability of the round.

If the effectiveness index type is MAE_b, the values of L_{ET} and W_{ET} are computed by the expression:

$$L_{ET} = W_{ET} = \sqrt{MAE_b} \tag{52}$$

and for VA_N the values are computed using the expressions:

$$L_{ET} = \frac{\sqrt{VA_N}}{\sin(I)} \tag{53}$$

$$W_{ET} = \sqrt{VA_N} \tag{54}$$

If the effectiveness index is in terms of EMD and the target is rectangular, the values of L_{ET} and W_{ET} are computed using the expressions:

$$L_{ET} = L_T + 2(EMD) \tag{55}$$

$$W_{ET} = W_T + 2(EMD) \tag{56}$$

where L_T is the target length and W is the target width. If the target is circular, the values are computed using the expression:

$$L_{ET} = W_{ET} = \sqrt{\pi}(R_T + EMD) \tag{57}$$

where R_T is the target radius. If target height is being considered, the shadow length (L_{SH}) is computed using the expression:

$$L_{SH} = \frac{H_T}{\tan(I)} \qquad (58)$$

where H_T is the target height. If the shadow length is greater than the effective miss distance, the value of L_{ET} is recomputed using the expression:

$$L_{ET} = \frac{[L_T + 2(EMD)](W_{ET}) + W_T(L_{SH} - EMD)}{W_{ET}} \qquad (59)$$

for rectangular targets, or:

$$L_{ET} = \frac{\pi(R_T + EMD)^2 + 2(R_T)(L_{SH} - EMD)}{\sqrt{\pi}(R_T + EMD)} \qquad (60)$$

for circular targets where all variables are defined above.

Next, four intermediate variables are computed by the expressions:

$$a_1 = \frac{L_{ET} + 2(R_O)}{2.96(REP)} \qquad (61)$$

$$a_2 = \frac{|L_{ET} - 2(R_O)|}{2.96(REP)} \qquad (62)$$

$$b_1 = \frac{W_{ET} + 2(R_O)}{2.96(DEP)} \qquad (63)$$

$$b_2 = \frac{|W_{ET} - 2(R_O)|}{2.96(DEP)} \qquad (64)$$

The range single shot probability of hit (RSSP) and the deflection single shot probability of hit (DSSP) are computed by the expressions:

$$\mathrm{RSSP} = \frac{1}{\sqrt{2\pi}} \int_0^{a_1} e^{-\frac{X^2}{2}} dx + \left[\begin{matrix}\text{Sign of} \\ L_{ET} - 2(R_O)\end{matrix}\right] \frac{1}{\sqrt{2\pi}} \int_0^{a_2} e^{-\frac{X^2}{2}} dx \qquad (65)$$

$$\mathrm{DSSP} = \frac{1}{\sqrt{2\pi}} \int_0^{b_1} e^{-\frac{X^2}{2}} dx + \left[\begin{matrix}\text{Sign of} \\ W_{ET} - 2(D_O)\end{matrix}\right] \frac{1}{\sqrt{2\pi}} \int_0^{b_2} e^{-\frac{X^2}{2}} dx \qquad (66)$$

and, finally, the single shot probability of damage (SSP_D) is computed by the expression:

$$SSP_D = RSSP(DSSP)(R)(P_{HD}) \qquad (67)$$

The cumulative probability of damage (P_D) for the N rounds in the volley is computed by the expression:

$$P_D = 1 - \prod_{i=1}^{N} (1 - SSP_{Di}) \qquad (68)$$

The value of P_D is compared to a random number from a uniform distribution (U_{RN}) and if the inequality:

$$U_{RN} < P_D \qquad (69)$$

is satisfied, the target is damaged and is removed from further consideration.

SECTION III

FLOWCHARTS

This section contains flowcharts which depict the logical structure of the main program and its 25 subroutines. All flowcharts are based upon the logical intent of this model rather than on displaying the methods used to code the specific routines. Program SEMAC (Figure 4) controls the program by calling the various processing subroutines. Subroutine READIN (Figure 5) reads the data cards and performs initializations and computations which are independent of the iteration. Subroutine SETUP (Figure 6) sets up data for each Monte Carlo iteration and determines mine locations, and Subroutine ROAD (Figure 7) rotates the mines, indirect fire volley aimpoints, and defender positions into the travel path coordinate system and places the targets at the beginning of the travel path segment. Subroutine BOOM (Figure 8) maintains the detonation flag bits for each mine, and Subroutine SORT (Figure 9) performs a Singleton sort on the event information array. Subroutine LOOPS (Figure 10) determines the next event, and Subroutine EVENTC (Figure 11) executes any event involving an intruder and a travel path segment boundary. Subroutine DIVSET (Figure 12) is called to record the location of an intruder which must be diverted around, and Subroutine DIVCHK (Figure 13) determines the offset distance if an intruder is diverting around another intruder. Subroutine UNIT (Figure 14) provides for the unit movement of intruders which are associated with another intruder as a group. Subroutine TGTMIN (Figure 15) determines the results of an encounter between an intruder and a mine, and Subroutine SYMDET (Figure 16) evaluates sympathetic detonations. Subroutine PRINTO (Figure 17) prints the optional output, Subroutine PRINTR (Figure 18) prints the results for each iteration, and Subroutine DISTR (Figure 19) computes and prints distribution output. Subroutine TABINT (Figure 20) performs standard linear interpolations of the tabular probability data, and Subroutine RNORM (Figure 21) selects a random number from a normal distribution. Subroutines IPACK (Figure 22) and UNPACK (Figure 23) pack and unpack data which describes the mines, travel path segment boundaries, and indirect fire volley aimpoints. Subroutine NDFIRE (Figure 24) evaluates the indirect fire munitions employed against the intruders while Subroutine DIRFIR (Figure 25) determines the results of the direct fire munitions employed as direct fire and return fire. Subroutine CKEVTM (Figure 26) determines the time related events, if any, to occur and sequences the events in the proper order. Subroutine STINT (Figure 27) maintains the flag bits for each intruder as they enter and leave direct fire areas. Subroutine EXPSWP (Figure 28) evaluates the effects of line charges and fuel air explosives against the mines within the range of influence. Finally, Subroutine TGTMOV (Figure 29) moves all active intruders the event distance and time and adjusts the assessed delays for all time related events that may occur.

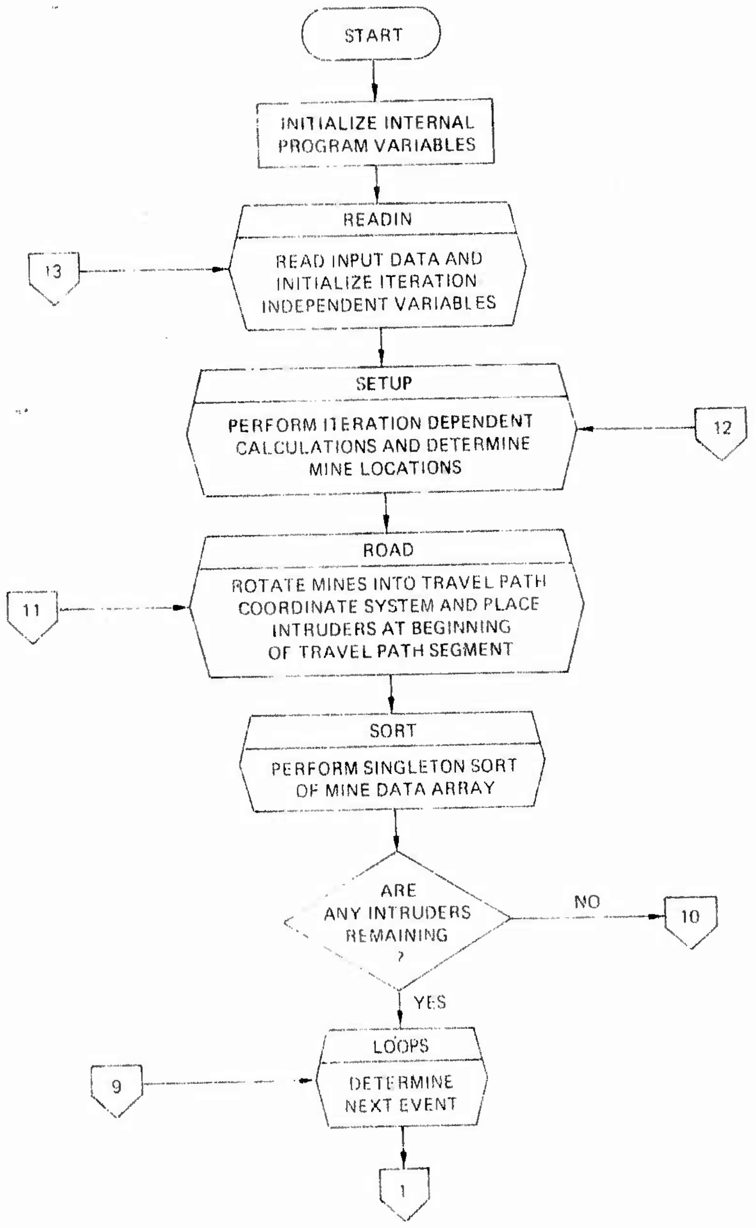

START
INITIALIZE INTERNAL PROGRAM VARIABLES
READIN
READ INPUT DATA AND INITIALIZE ITERATION INDEPENDENT VARIABLES
13
SETUP
PERFORM ITERATION DEPENDENT CALCULATIONS AND DETERMINE MINE LOCATIONS
12
ROAD
ROTATE MINES INTO TRAVEL PATH COORDINATE SYSTEM AND PLACE INTRUDERS AT BEGINNING OF TRAVEL PATH SEGMENT
11
SORT
PERFORM SINGLETON SORT OF MINE DATA ARRAY
ARE ANY INTRUDERS REMAINING ?
NO
10
YES
LOOPS
DETERMINE NEXT EVENT
9
1

Figure 4. Flowchart, Program SEMAC

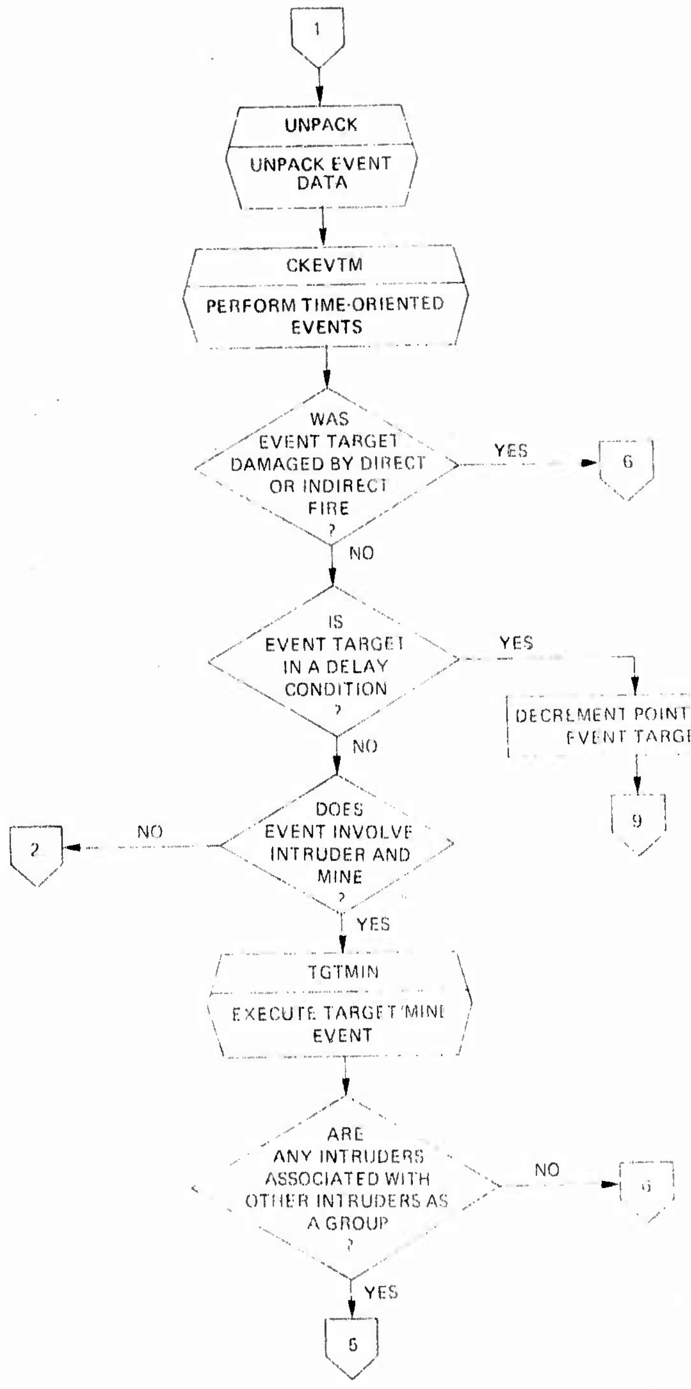

1
UNPACK
UNPACK EVENT DATA
CKEVTM
PERFORM TIME-ORIENTED EVENTS
WAS EVENT TARGET DAMAGED BY DIRECT OR INDIRECT FIRE ?
YES
6
NO
IS EVENT TARGET IN A DELAY CONDITION ?
YES
DECREMENT POINTER FOR EVENT TARGET
9
NO
DOES EVENT INVOLVE INTRUDER AND MINE ?
NO
2
YES
TGTMIN
EXECUTE TARGET/MINE EVENT
ARE ANY INTRUDERS ASSOCIATED WITH OTHER INTRUDERS AS A GROUP ?
NO
6
YES
5

Figure 4. (Continued)

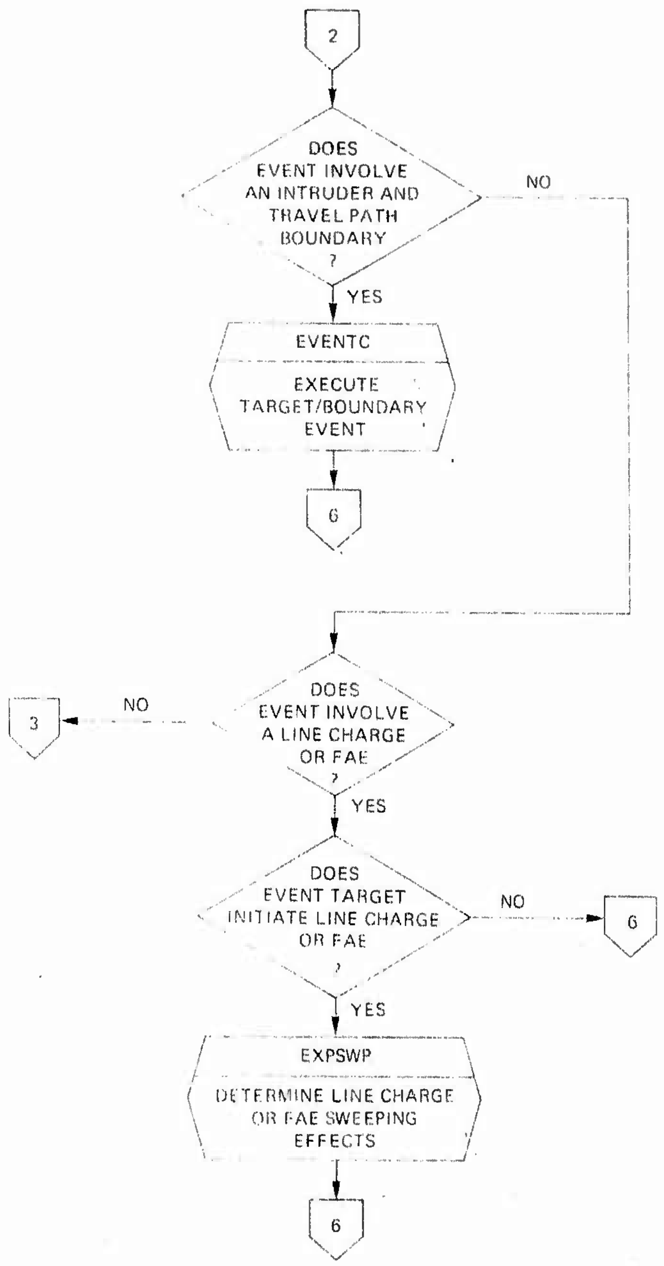

2
DOES EVENT INVOLVE AN INTRUDER AND TRAVEL PATH BOUNDARY ?
NO
YES
EVENTC
EXECUTE TARGET/BOUNDARY EVENT
6
DOES EVENT INVOLVE A LINE CHARGE OR FAE ?
NO
3
YES
DOES EVENT TARGET INITIATE LINE CHARGE OR FAE ?
NO
6
YES
EXPSWP
DETERMINE LINE CHARGE OR FAE SWEEPING EFFECTS
6

Figure 4. (Continued)

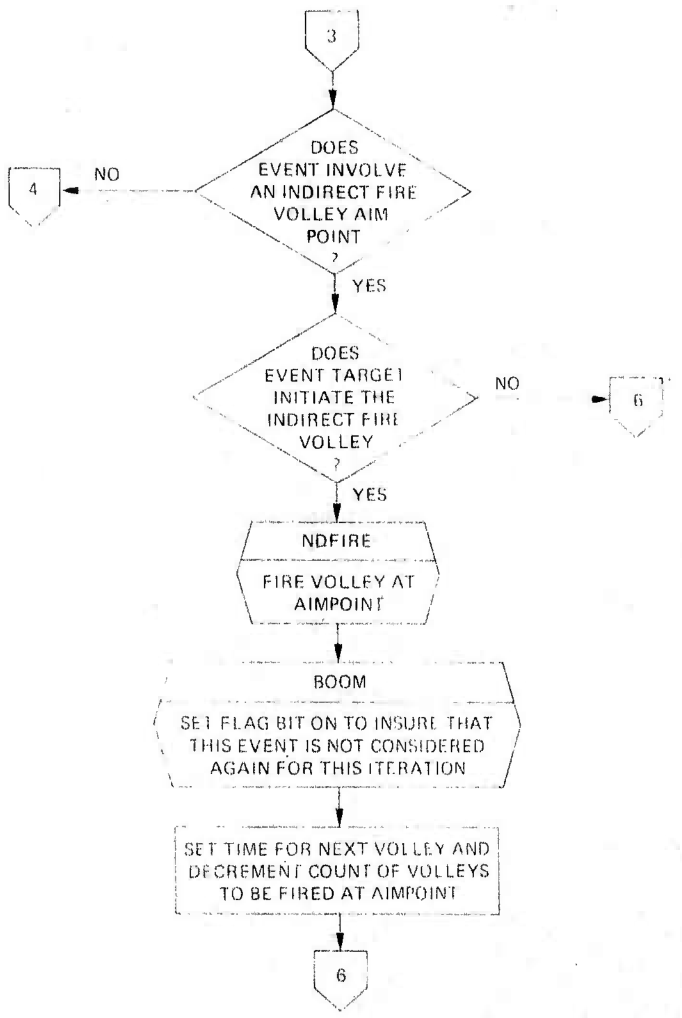

3
DOES EVENT INVOLVE AN INDIRECT FIRE VOLLEY AIM POINT ?
NO
4
YES
DOES EVENT TARGET INITIATE THE INDIRECT FIRE VOLLEY ?
NO
6
YES
NDFIRE
FIRE VOLLEY AT AIMPOINT
BOOM
SET FLAG BIT ON TO INSURE THAT THIS EVENT IS NOT CONSIDERED AGAIN FOR THIS ITERATION
SET TIME FOR NEXT VOLLEY AND DECREMENT COUNT OF VOLLEYS TO BE FIRED AT AIMPOINT
6

Figure 4. (Continued)

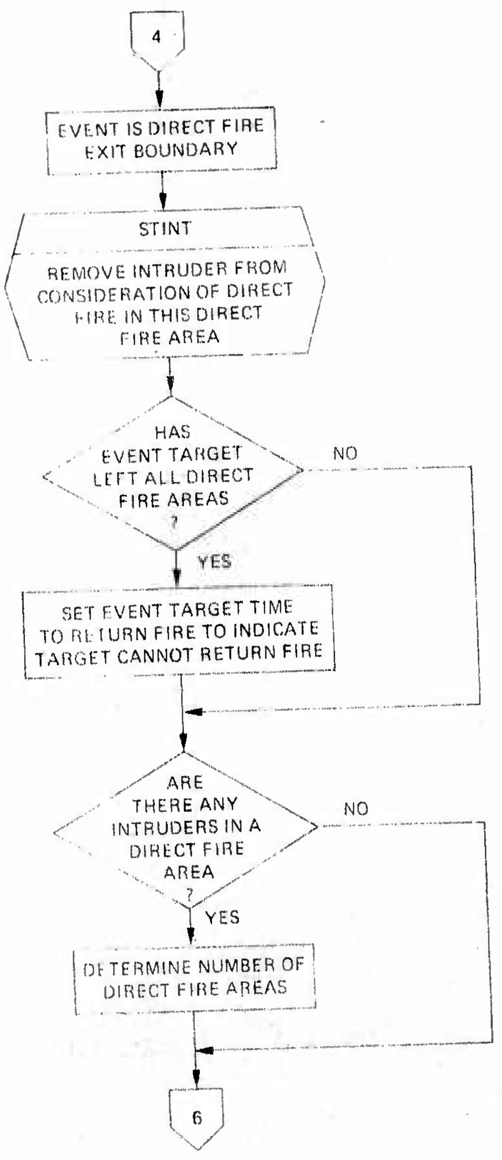

4
EVENT IS DIRECT FIRE EXIT BOUNDARY
STINT
REMOVE INTRUDER FROM CONSIDERATION OF DIRECT FIRE IN THIS DIRECT FIRE AREA
HAS EVENT TARGET LEFT ALL DIRECT FIRE AREAS ?
NO
YES
SET EVENT TARGET TIME TO RETURN FIRE TO INDICATE TARGET CANNOT RETURN FIRE
ARE THERE ANY INTRUDERS IN A DIRECT FIRE AREA ?
NO
YES
DETERMINE NUMBER OF DIRECT FIRE AREAS
6

Figure 4. (Continued)

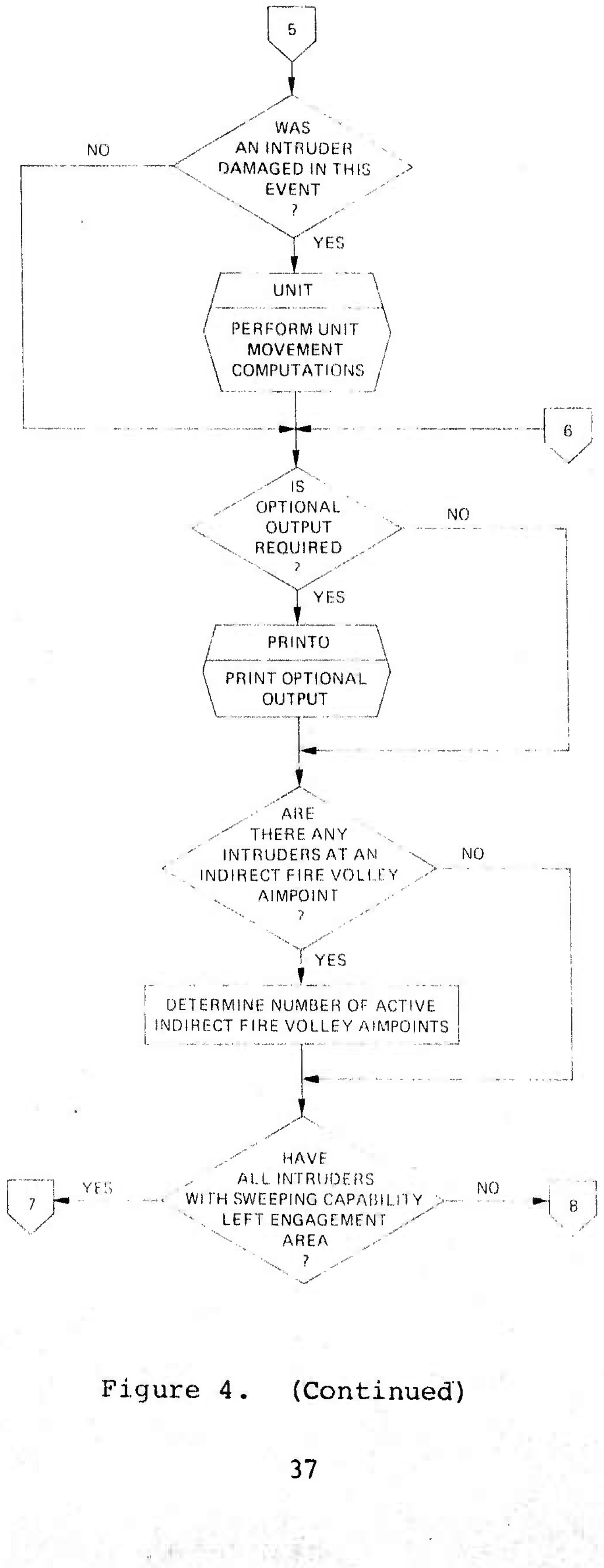

5
WAS AN INTRUDER DAMAGED IN THIS EVENT ?
NO
YES
UNIT
PERFORM UNIT MOVEMENT COMPUTATIONS
6
IS OPTIONAL OUTPUT REQUIRED ?
NO
YES
PRINTO
PRINT OPTIONAL OUTPUT
ARE THERE ANY INTRUDERS AT AN INDIRECT FIRE VOLLEY AIMPOINT ?
NO
YES
DETERMINE NUMBER OF ACTIVE INDIRECT FIRE VOLLEY AIMPOINTS
HAVE ALL INTRUDERS WITH SWEEPING CAPABILITY LEFT ENGAGEMENT AREA ?
YES
7
NO
8

Figure 4. (Continued)

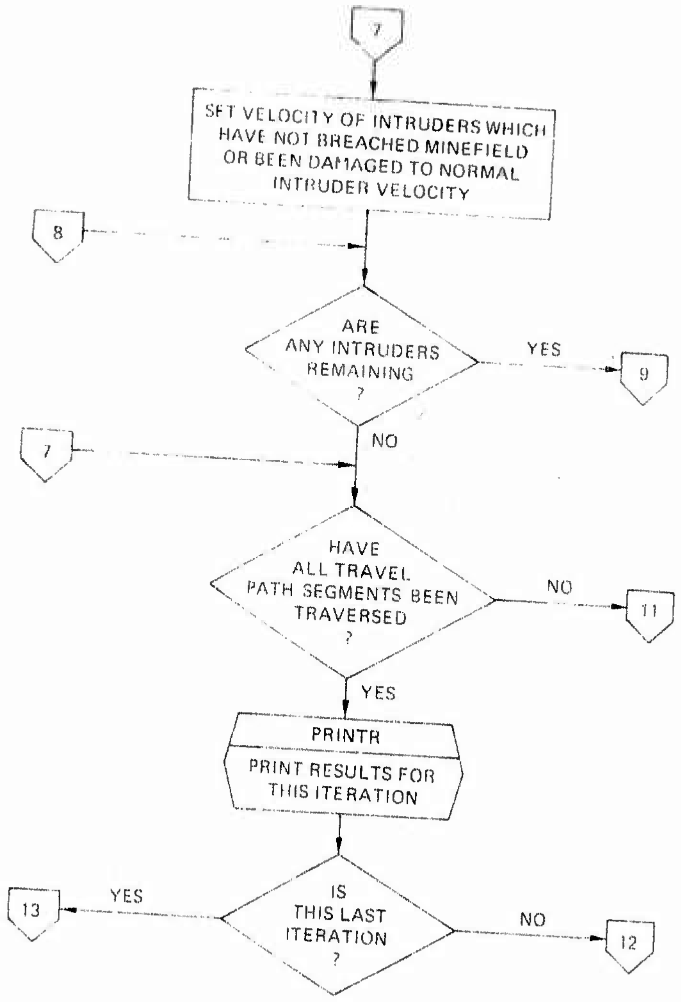

7
SET VELOCITY OF INTRUDERS WHICH HAVE NOT BREACHED MINEFIELD OR BEEN DAMAGED TO NORMAL INTRUDER VELOCITY
8
ARE ANY INTRUDERS REMAINING ?
YES
9
NO
7
HAVE ALL TRAVEL PATH SEGMENTS BEEN TRAVERSED ?
NO
11
YES
PRINTR
PRINT RESULTS FOR THIS ITERATION
IS THIS LAST ITERATION ?
YES
13
NO
12

Figure 4. (Concluded)

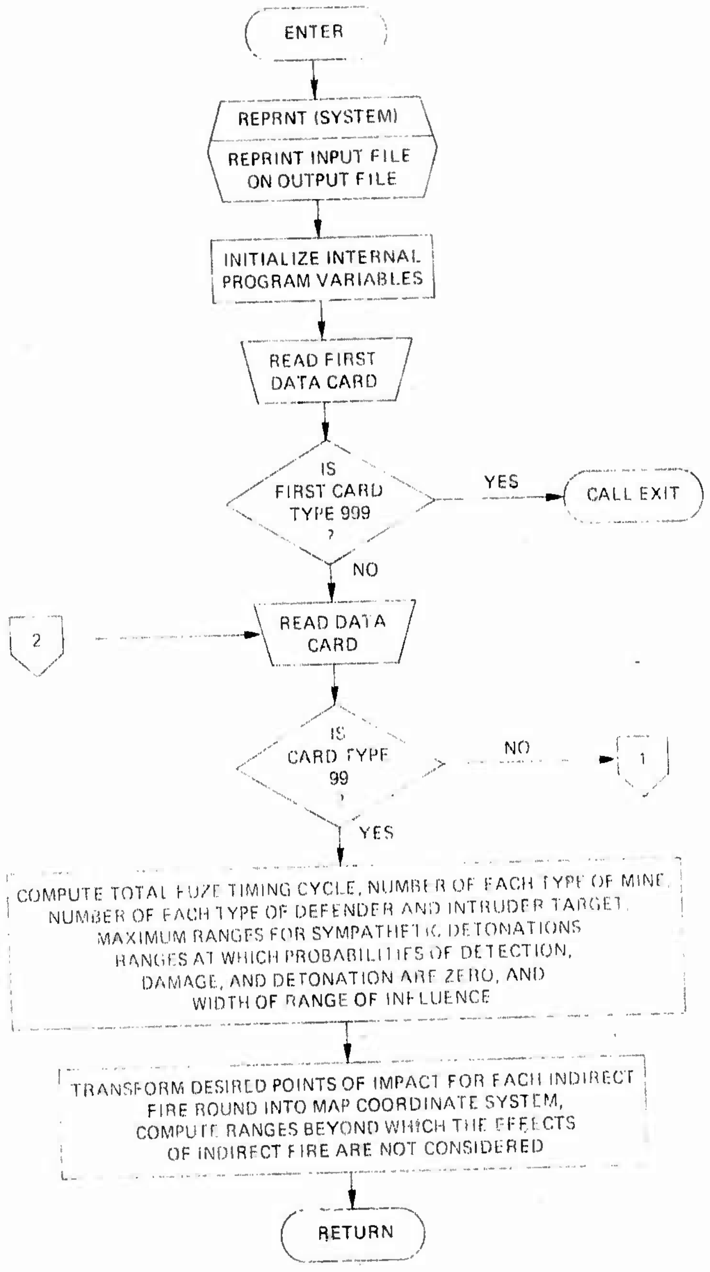

ENTER
REPRNT (SYSTEM)
REPRINT INPUT FILE ON OUTPUT FILE
INITIALIZE INTERNAL PROGRAM VARIABLES
READ FIRST DATA CARD
IS FIRST CARD TYPE 999 ?
YES
CALL EXIT
NO
2
READ DATA CARD
IS CARD TYPE 99 ?
NO
1
YES
COMPUTE TOTAL FUZE TIMING CYCLE, NUMBER OF EACH TYPE OF MINE, NUMBER OF EACH TYPE OF DEFENDER AND INTRUDER TARGET, MAXIMUM RANGES FOR SYMPATHETIC DETONATIONS RANGES AT WHICH PROBABILITIES OF DETECTION, DAMAGE, AND DETONATION ARE ZERO, AND WIDTH OF RANGE OF INFLUENCE
TRANSFORM DESIRED POINTS OF IMPACT FOR EACH INDIRECT FIRE ROUND INTO MAP COORDINATE SYSTEM, COMPUTE RANGES BEYOND WHICH THE EFFECTS OF INDIRECT FIRE ARE NOT CONSIDERED
RETURN

Figure 5. Flowchart, Subroutine READIN

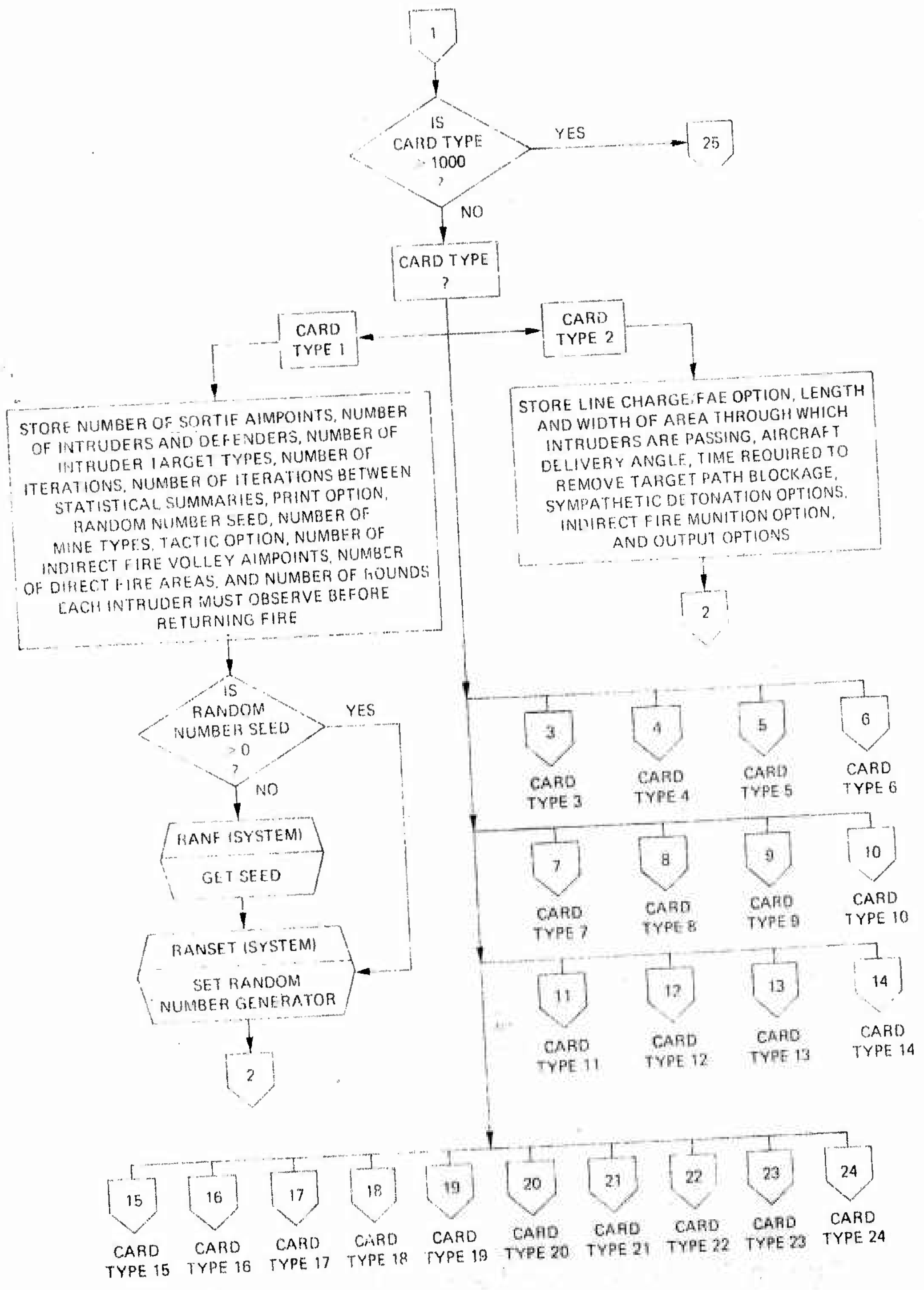

1
IS CARD TYPE > 1000 ?
YES
25
NO
CARD TYPE ?
CARD TYPE 1
CARD TYPE 2
STORE NUMBER OF SORTIE AIMPOINTS, NUMBER OF INTRUDERS AND DEFENDERS, NUMBER OF INTRUDER TARGET TYPES, NUMBER OF ITERATIONS, NUMBER OF ITERATIONS BETWEEN STATISTICAL SUMMARIES, PRINT OPTION, RANDOM NUMBER SEED, NUMBER OF MINE TYPES, TACTIC OPTION, NUMBER OF INDIRECT FIRE VOLLEY AIMPOINTS, NUMBER OF DIRECT FIRE AREAS, AND NUMBER OF ROUNDS EACH INTRUDER MUST OBSERVE BEFORE RETURNING FIRE
STORE LINE CHARGE/FAE OPTION, LENGTH AND WIDTH OF AREA THROUGH WHICH INTRUDERS ARE PASSING, AIRCRAFT DELIVERY ANGLE, TIME REQUIRED TO REMOVE TARGET PATH BLOCKAGE, SYMPATHETIC DETONATION OPTIONS, INDIRECT FIRE MUNITION OPTION, AND OUTPUT OPTIONS
2
IS RANDOM NUMBER SEED > 0 ?
YES
NO
RANF (SYSTEM)
GET SEED
RANSET (SYSTEM)
SET RANDOM NUMBER GENERATOR
2
3 CARD TYPE 3
4 CARD TYPE 4
5 CARD TYPE 5
6 CARD TYPE 6
7 CARD TYPE 7
8 CARD TYPE 8
9 CARD TYPE 9
10 CARD TYPE 10
11 CARD TYPE 11
12 CARD TYPE 12
13 CARD TYPE 13
14 CARD TYPE 14
15 CARD TYPE 15
16 CARD TYPE 16
17 CARD TYPE 17
18 CARD TYPE 18
19 CARD TYPE 19
20 CARD TYPE 20
21 CARD TYPE 21
22 CARD TYPE 22
23 CARD TYPE 23
24 CARD TYPE 24

Figure 5. (Continued)

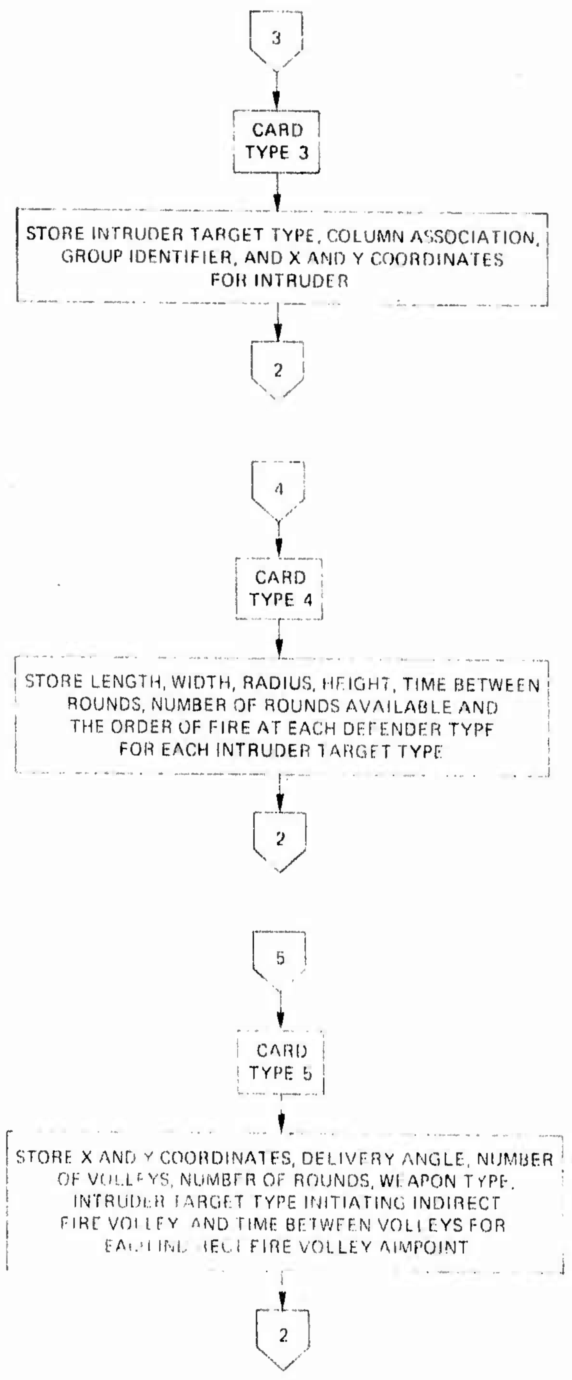

3
CARD TYPE 3
STORE INTRUDER TARGET TYPE, COLUMN ASSOCIATION, GROUP IDENTIFIER, AND X AND Y COORDINATES FOR INTRUDER
2
4
CARD TYPE 4
STORE LENGTH, WIDTH, RADIUS, HEIGHT, TIME BETWEEN ROUNDS, NUMBER OF ROUNDS AVAILABLE AND THE ORDER OF FIRE AT EACH DEFENDER TYPE FOR EACH INTRUDER TARGET TYPE
2
5
CARD TYPE 5
STORE X AND Y COORDINATES, DELIVERY ANGLE, NUMBER OF VOLLEYS, NUMBER OF ROUNDS, WEAPON TYPE, INTRUDER TARGET TYPE INITIATING INDIRECT FIRE VOLLEY AND TIME BETWEEN VOLLEYS FOR EACH INDIRECT FIRE VOLLEY AIMPOINT
2

Figure 5. (Continued)

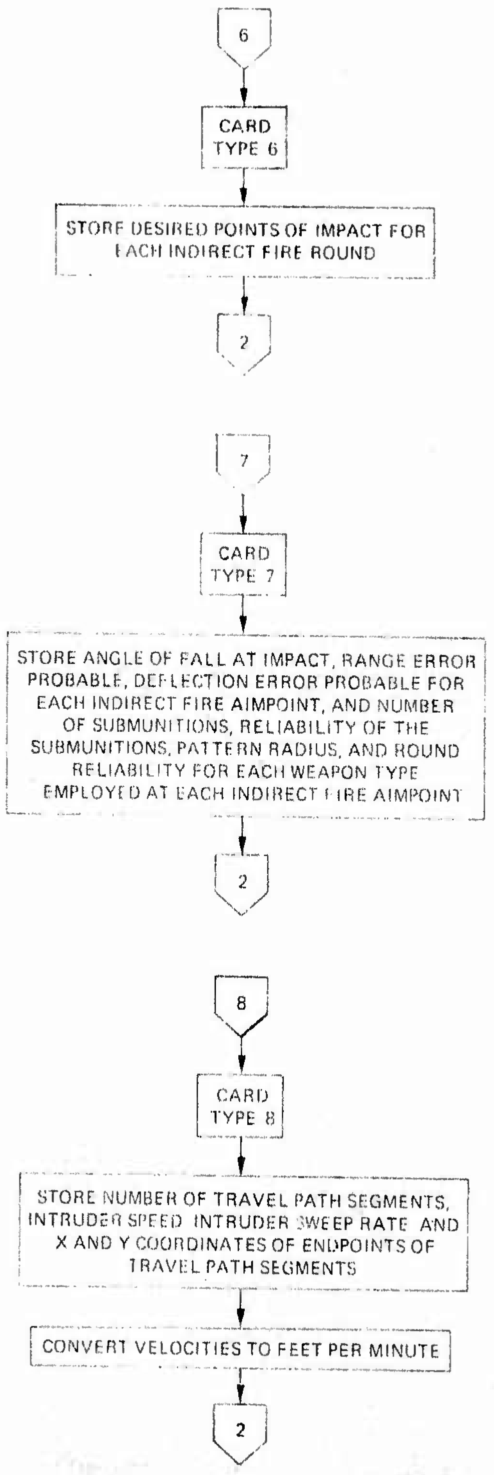

6
CARD TYPE 6
STORE DESIRED POINTS OF IMPACT FOR EACH INDIRECT FIRE ROUND
2
7
CARD TYPE 7
STORE ANGLE OF FALL AT IMPACT, RANGE ERROR PROBABLE, DEFLECTION ERROR PROBABLE FOR EACH INDIRECT FIRE AIMPOINT, AND NUMBER OF SUBMUNITIONS, RELIABILITY OF THE SUBMUNITIONS, PATTERN RADIUS, AND ROUND RELIABILITY FOR EACH WEAPON TYPE EMPLOYED AT EACH INDIRECT FIRE AIMPOINT
2
8
CARD TYPE 8
STORE NUMBER OF TRAVEL PATH SEGMENTS, INTRUDER SPEED INTRUDER SWEEP RATE AND X AND Y COORDINATES OF ENDPOINTS OF TRAVEL PATH SEGMENTS
CONVERT VELOCITIES TO FEET PER MINUTE
2

Figure 5. (Continued)

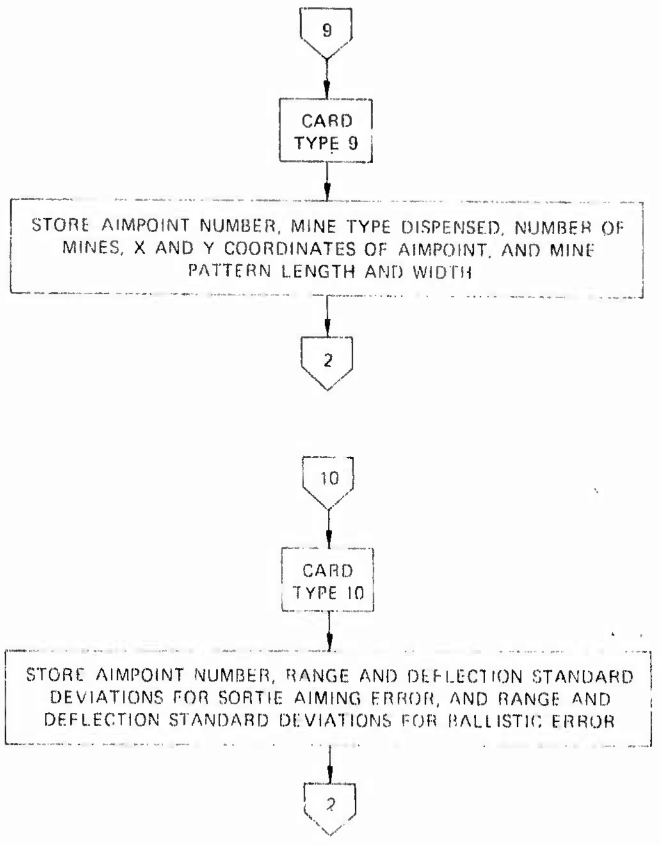

9
CARD TYPE 9
STORE AIMPOINT NUMBER, MINE TYPE DISPENSED, NUMBER OF MINES, X AND Y COORDINATES OF AIMPOINT, AND MINE PATTERN LENGTH AND WIDTH
2
10
CARD TYPE 10
STORE AIMPOINT NUMBER, RANGE AND DEFLECTION STANDARD DEVIATIONS FOR SORTIE AIMING ERROR, AND RANGE AND DEFLECTION STANDARD DEVIATIONS FOR BALLISTIC ERROR
2

Figure 5. (Continued)

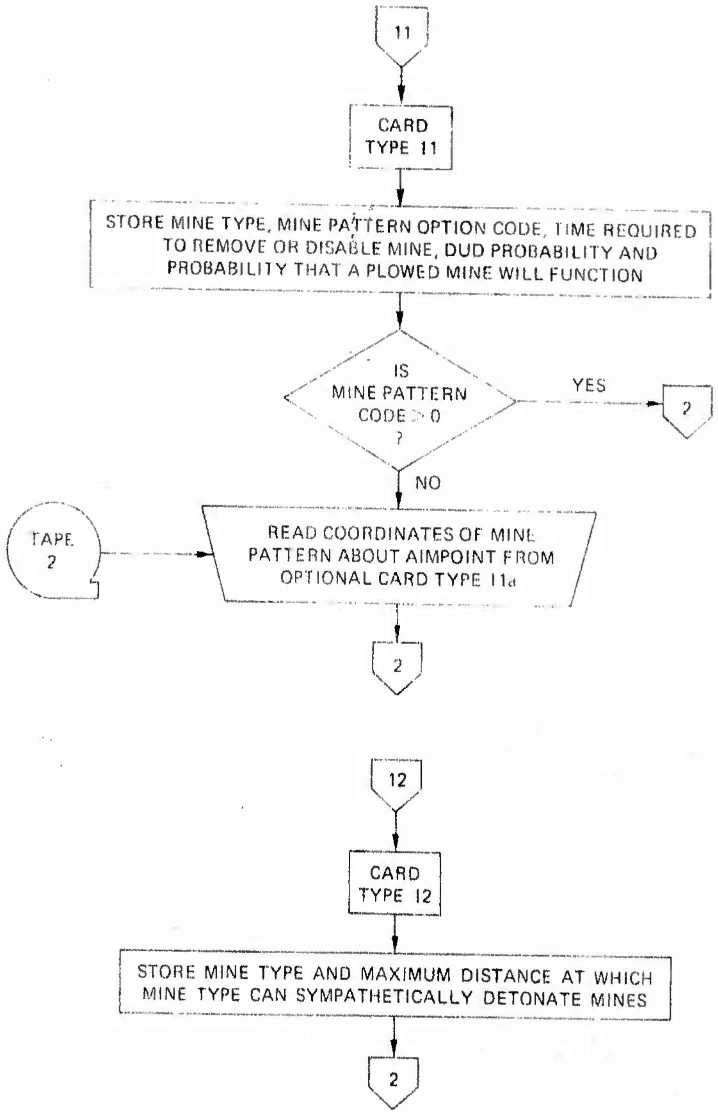

11
CARD TYPE 11
STORE MINE TYPE, MINE PATTERN OPTION CODE, TIME REQUIRED TO REMOVE OR DISABLE MINE, DUD PROBABILITY AND PROBABILITY THAT A PLOWED MINE WILL FUNCTION
IS MINE PATTERN CODE > 0 ?
YES
2
NO
TAPE 2
READ COORDINATES OF MINE PATTERN ABOUT AIMPOINT FROM OPTIONAL CARD TYPE 11a
2
12
CARD TYPE 12
STORE MINE TYPE AND MAXIMUM DISTANCE AT WHICH MINE TYPE CAN SYMPATHETICALLY DETONATE MINES
2

Figure 5. (Continued)

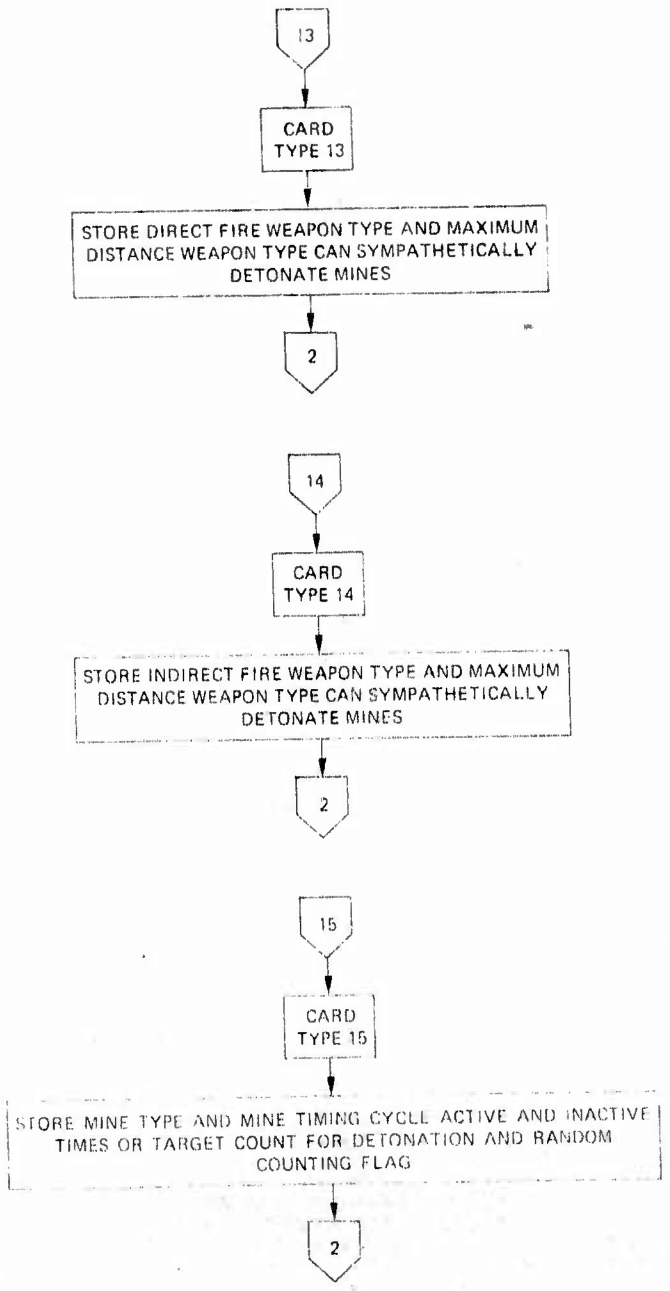

13
CARD TYPE 13
STORE DIRECT FIRE WEAPON TYPE AND MAXIMUM DISTANCE WEAPON TYPE CAN SYMPATHETICALLY DETONATE MINES
2
14
CARD TYPE 14
STORE INDIRECT FIRE WEAPON TYPE AND MAXIMUM DISTANCE WEAPON TYPE CAN SYMPATHETICALLY DETONATE MINES
2
15
CARD TYPE 15
STORE MINE TYPE AND MINE TIMING CYCLE ACTIVE AND INACTIVE TIMES OR TARGET COUNT FOR DETONATION AND RANDOM COUNTING FLAG
2

Figure 5. (Continued)

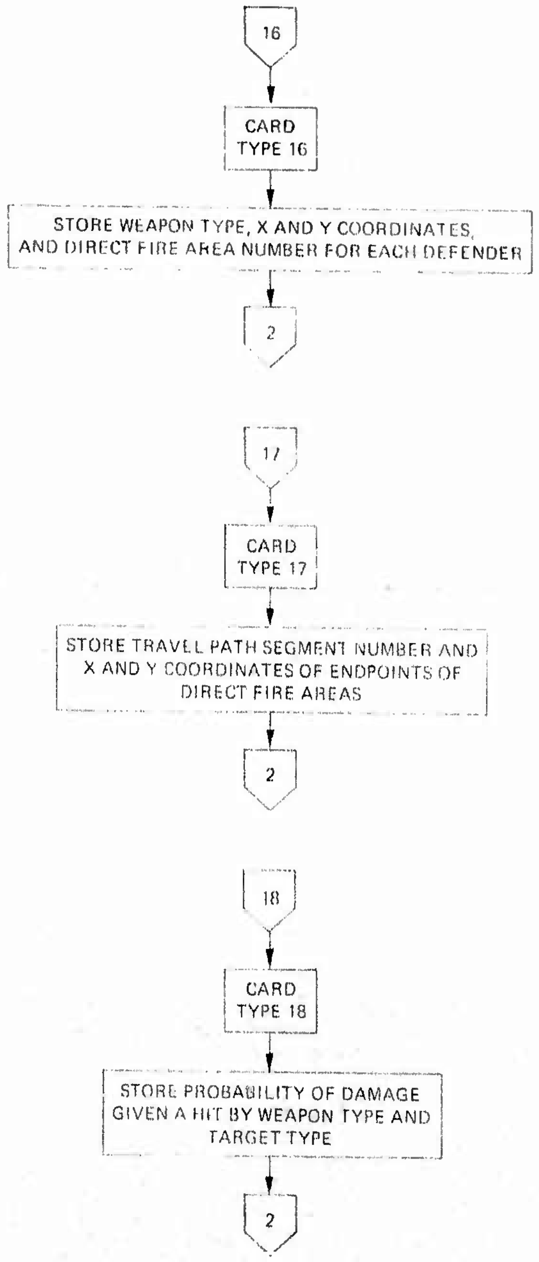

16
CARD TYPE 16
STORE WEAPON TYPE, X AND Y COORDINATES, AND DIRECT FIRE AREA NUMBER FOR EACH DEFENDER
2
17
CARD TYPE 17
STORE TRAVEL PATH SEGMENT NUMBER AND X AND Y COORDINATES OF ENDPOINTS OF DIRECT FIRE AREAS
2
18
CARD TYPE 18
STORE PROBABILITY OF DAMAGE GIVEN A HIT BY WEAPON TYPE AND TARGET TYPE
2

Figure 5. (Continued)

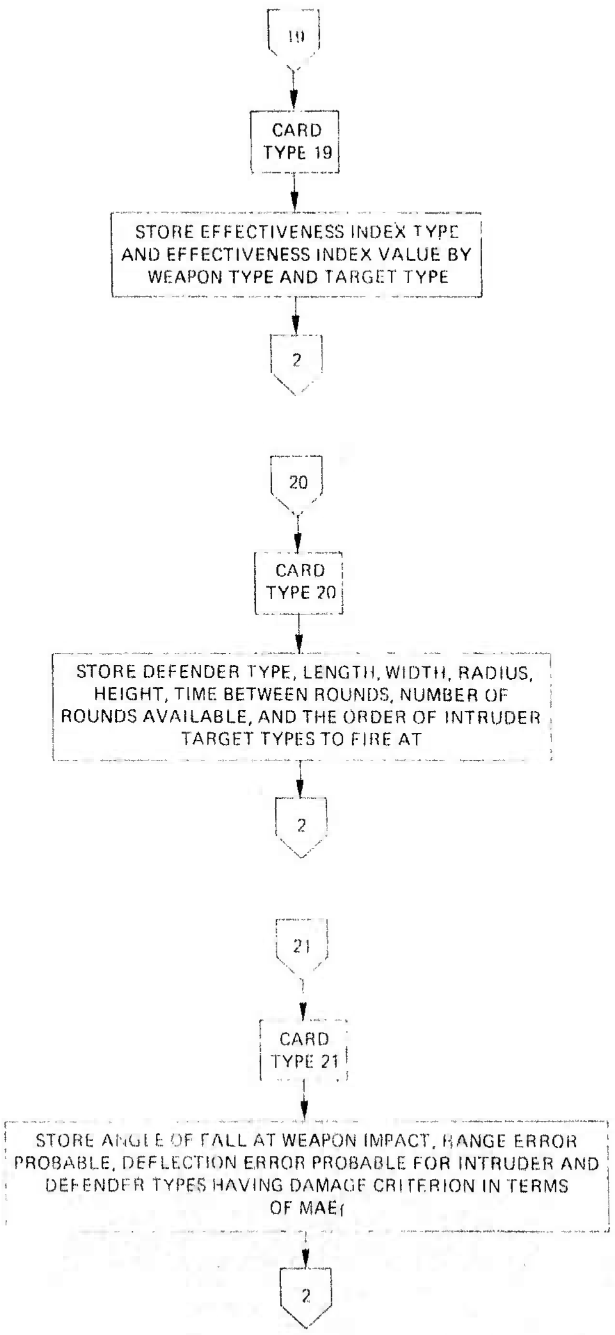

19
CARD TYPE 19
STORE EFFECTIVENESS INDEX TYPE AND EFFECTIVENESS INDEX VALUE BY WEAPON TYPE AND TARGET TYPE
2
20
CARD TYPE 20
STORE DEFENDER TYPE, LENGTH, WIDTH, RADIUS, HEIGHT, TIME BETWEEN ROUNDS, NUMBER OF ROUNDS AVAILABLE, AND THE ORDER OF INTRUDER TARGET TYPES TO FIRE AT
2
21
CARD TYPE 21
STORE ANGLE OF FALL AT WEAPON IMPACT, RANGE ERROR PROBABLE, DEFLECTION ERROR PROBABLE FOR INTRUDER AND DEFENDER TYPES HAVING DAMAGE CRITERION IN TERMS OF MAEf
2

Figure 5. (Continued)

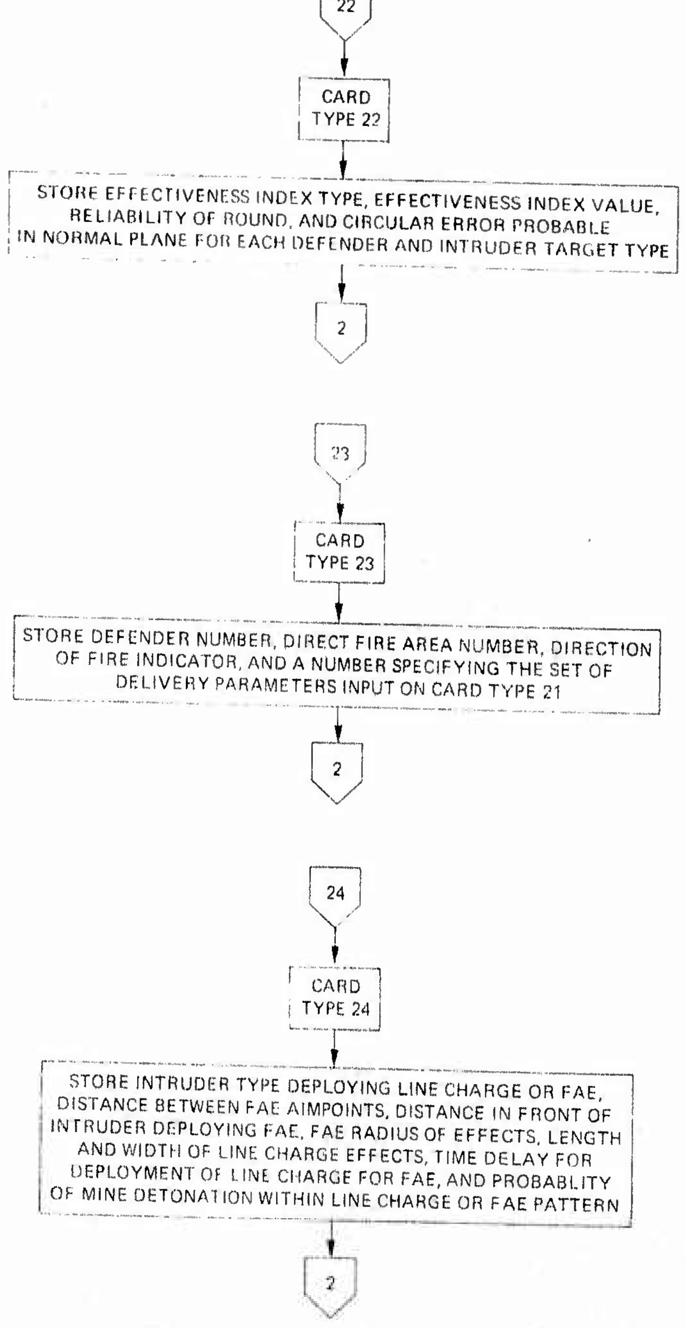

22
CARD TYPE 22
STORE EFFECTIVENESS INDEX TYPE, EFFECTIVENESS INDEX VALUE, RELIABILITY OF ROUND, AND CIRCULAR ERROR PROBABLE IN NORMAL PLANE FOR EACH DEFENDER AND INTRUDER TARGET TYPE
2
23
CARD TYPE 23
STORE DEFENDER NUMBER, DIRECT FIRE AREA NUMBER, DIRECTION OF FIRE INDICATOR, AND A NUMBER SPECIFYING THE SET OF DELIVERY PARAMETERS INPUT ON CARD TYPE 21
2
24
CARD TYPE 24
STORE INTRUDER TYPE DEPLOYING LINE CHARGE OR FAE, DISTANCE BETWEEN FAE AIMPOINTS, DISTANCE IN FRONT OF INTRUDER DEPLOYING FAE, FAE RADIUS OF EFFECTS, LENGTH AND WIDTH OF LINE CHARGE EFFECTS, TIME DELAY FOR DEPLOYMENT OF LINE CHARGE FOR FAE, AND PROBABLITY OF MINE DETONATION WITHIN LINE CHARGE OR FAE PATTERN
2

Figure 5. (Continued)

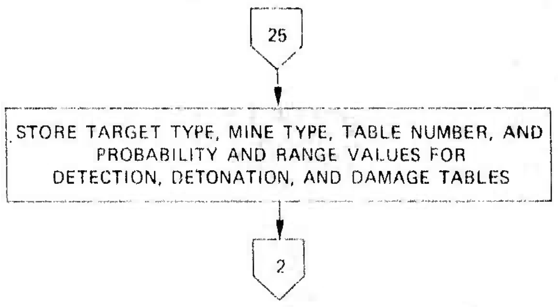

25
STORE TARGET TYPE, MINE TYPE, TABLE NUMBER, AND PROBABILITY AND RANGE VALUES FOR DETECTION, DETONATION, AND DAMAGE TABLES
2

Figure 5. (Concluded)

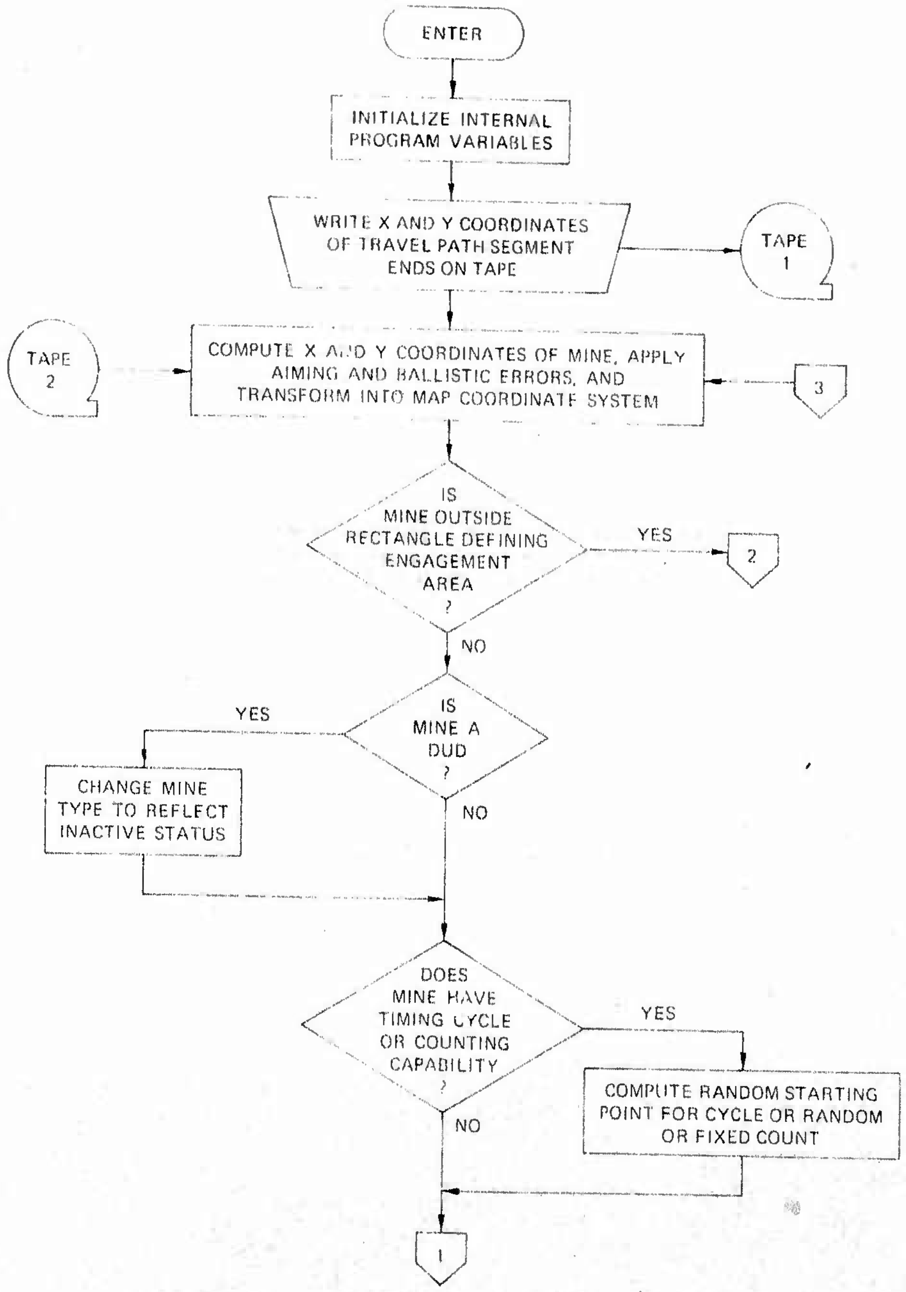

ENTER
INITIALIZE INTERNAL PROGRAM VARIABLES
WRITE X AND Y COORDINATES OF TRAVEL PATH SEGMENT ENDS ON TAPE
TAPE 1
TAPE 2
COMPUTE X AND Y COORDINATES OF MINE, APPLY AIMING AND BALLISTIC ERRORS, AND TRANSFORM INTO MAP COORDINATE SYSTEM
3
IS MINE OUTSIDE RECTANGLE DEFINING ENGAGEMENT AREA ?
YES
2
NO
IS MINE A DUD ?
YES
CHANGE MINE TYPE TO REFLECT INACTIVE STATUS
NO
DOES MINE HAVE TIMING CYCLE OR COUNTING CAPABILITY ?
YES
COMPUTE RANDOM STARTING POINT FOR CYCLE OR RANDOM OR FIXED COUNT
NO
1

Figure 6. Flowchart, Subroutine SETUP

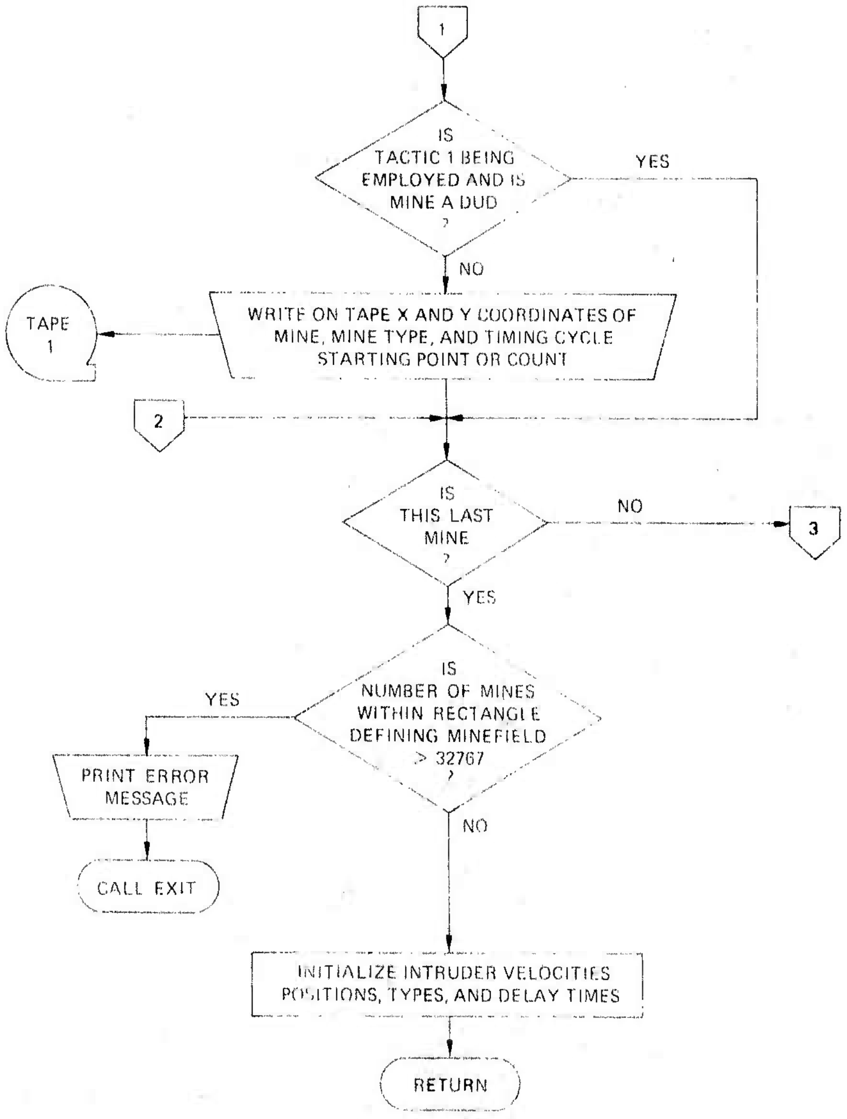

1
IS TACTIC 1 BEING EMPLOYED AND IS MINE A DUD ?
YES
NO
WRITE ON TAPE X AND Y COORDINATES OF MINE, MINE TYPE, AND TIMING CYCLE STARTING POINT OR COUNT
TAPE 1
2
IS THIS LAST MINE ?
NO
3
YES
IS NUMBER OF MINES WITHIN RECTANGLE DEFINING MINEFIELD > 32767 ?
YES
PRINT ERROR MESSAGE
CALL EXIT
NO
INITIALIZE INTRUDER VELOCITIES POSITIONS, TYPES, AND DELAY TIMES
RETURN

Figure 6. (Concluded)

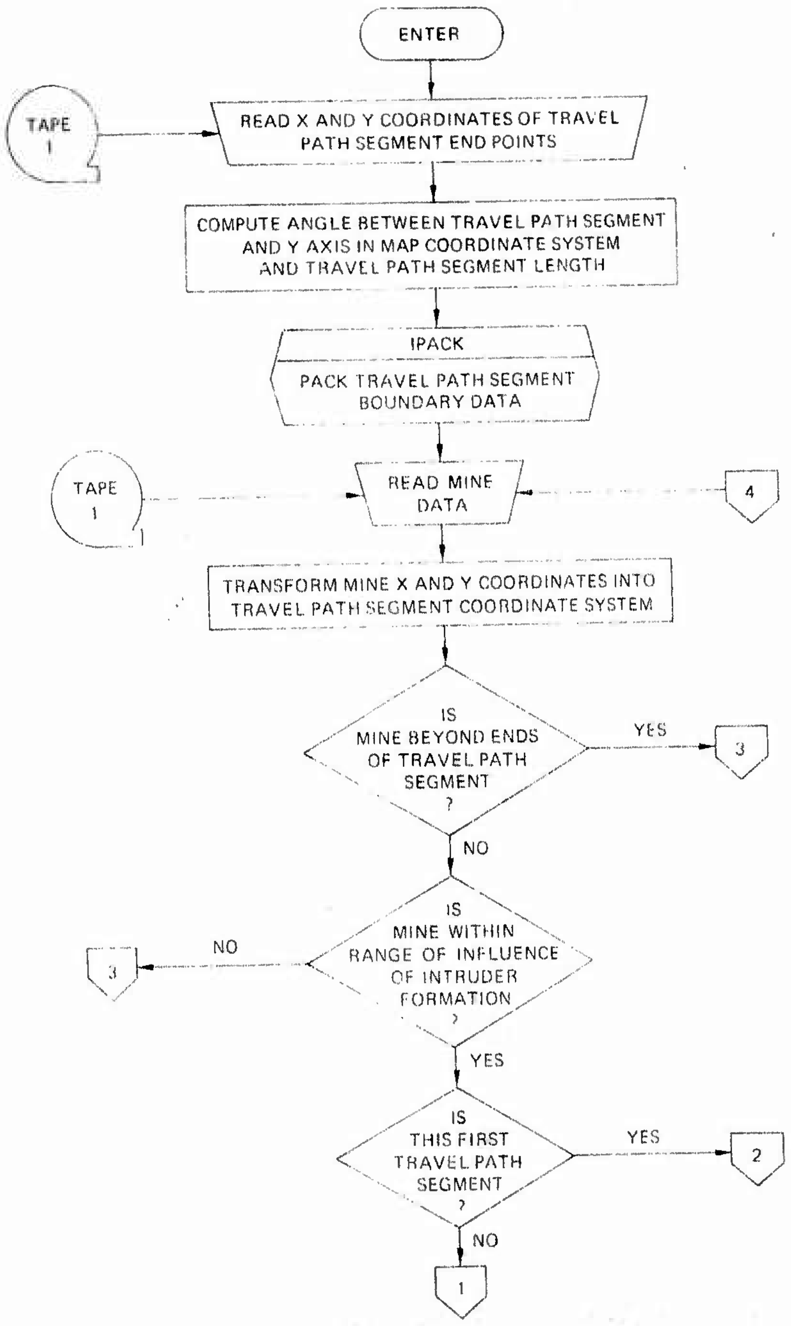

ENTER
TAPE 1
READ X AND Y COORDINATES OF TRAVEL PATH SEGMENT END POINTS
COMPUTE ANGLE BETWEEN TRAVEL PATH SEGMENT AND Y AXIS IN MAP COORDINATE SYSTEM AND TRAVEL PATH SEGMENT LENGTH
IPACK
PACK TRAVEL PATH SEGMENT BOUNDARY DATA
TAPE 1
READ MINE DATA
4
TRANSFORM MINE X AND Y COORDINATES INTO TRAVEL PATH SEGMENT COORDINATE SYSTEM
IS MINE BEYOND ENDS OF TRAVEL PATH SEGMENT ?
YES
3
NO
IS MINE WITHIN RANGE OF INFLUENCE OF INTRUDER FORMATION ?
NO
3
YES
IS THIS FIRST TRAVEL PATH SEGMENT ?
YES
2
NO
1

Figure 7. Flowchart, Subroutine ROAD

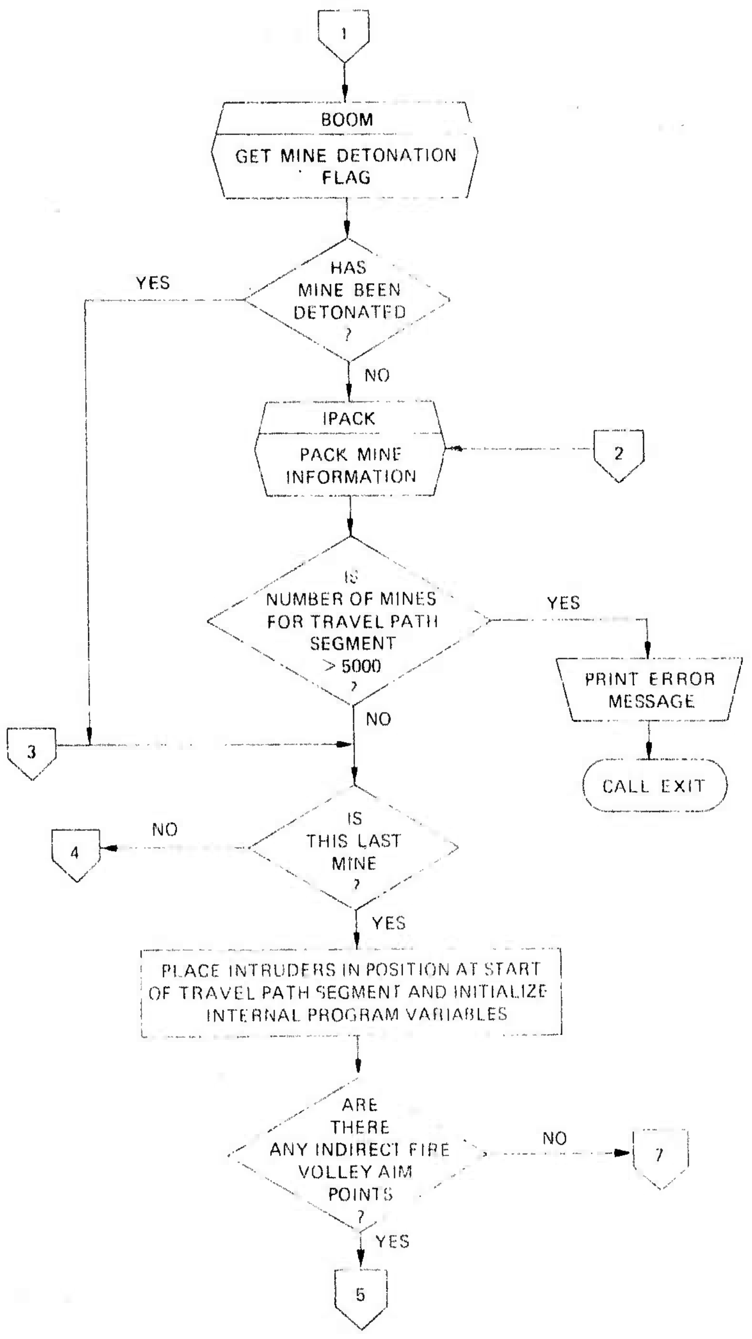

1
BOOM
GET MINE DETONATION FLAG
HAS MINE BEEN DETONATED ?
YES
NO
IPACK
PACK MINE INFORMATION
2
IS NUMBER OF MINES FOR TRAVEL PATH SEGMENT > 5000 ?
YES
PRINT ERROR MESSAGE
CALL EXIT
NO
3
IS THIS LAST MINE ?
NO
4
YES
PLACE INTRUDERS IN POSITION AT START OF TRAVEL PATH SEGMENT AND INITIALIZE INTERNAL PROGRAM VARIABLES
ARE THERE ANY INDIRECT FIRE VOLLEY AIM POINTS ?
NO
7
YES
5

Figure 7. (Continued)

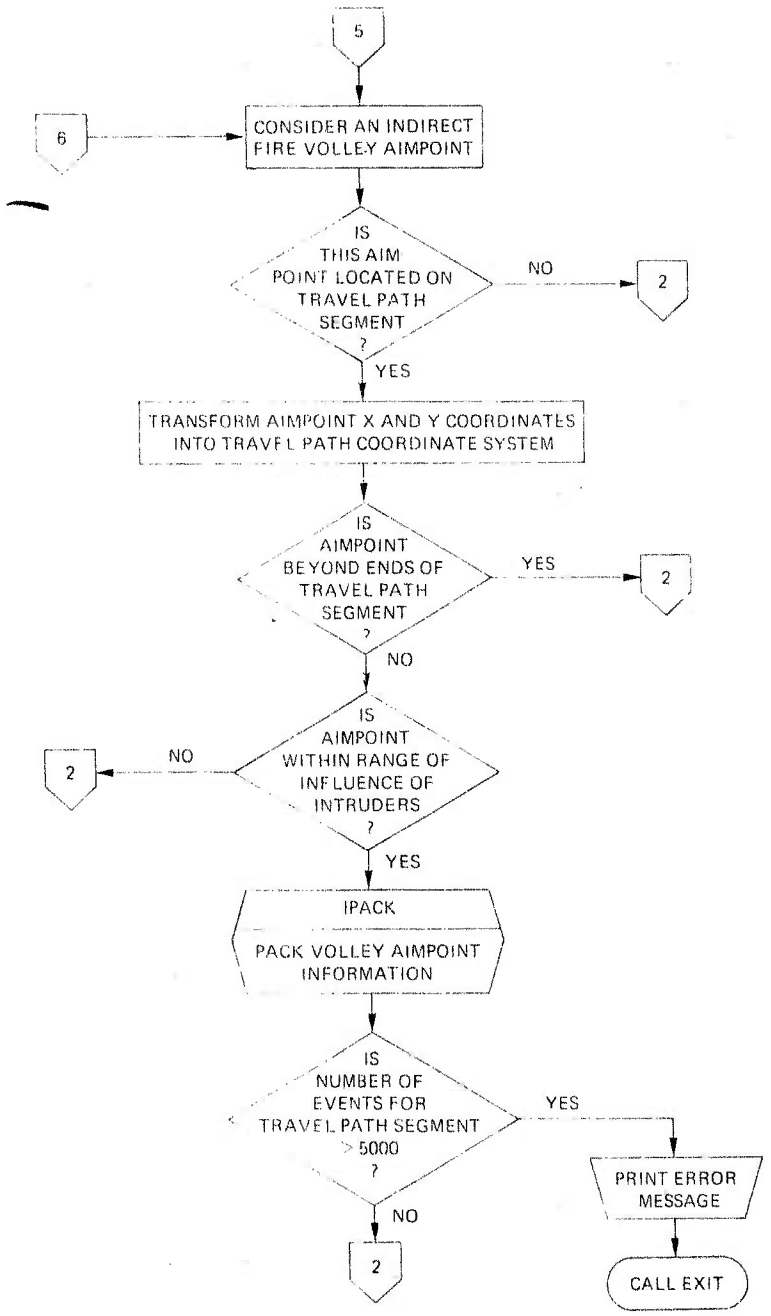

5
6
CONSIDER AN INDIRECT FIRE VOLLEY AIMPOINT
IS THIS AIM POINT LOCATED ON TRAVEL PATH SEGMENT ?
NO
2
YES
TRANSFORM AIMPOINT X AND Y COORDINATES INTO TRAVEL PATH COORDINATE SYSTEM
IS AIMPOINT BEYOND ENDS OF TRAVEL PATH SEGMENT ?
YES
2
NO
IS AIMPOINT WITHIN RANGE OF INFLUENCE OF INTRUDERS ?
NO
2
YES
IPACK
PACK VOLLEY AIMPOINT INFORMATION
IS NUMBER OF EVENTS FOR TRAVEL PATH SEGMENT > 5000 ?
YES
PRINT ERROR MESSAGE
CALL EXIT
NO
2

Figure 7. (Continued)

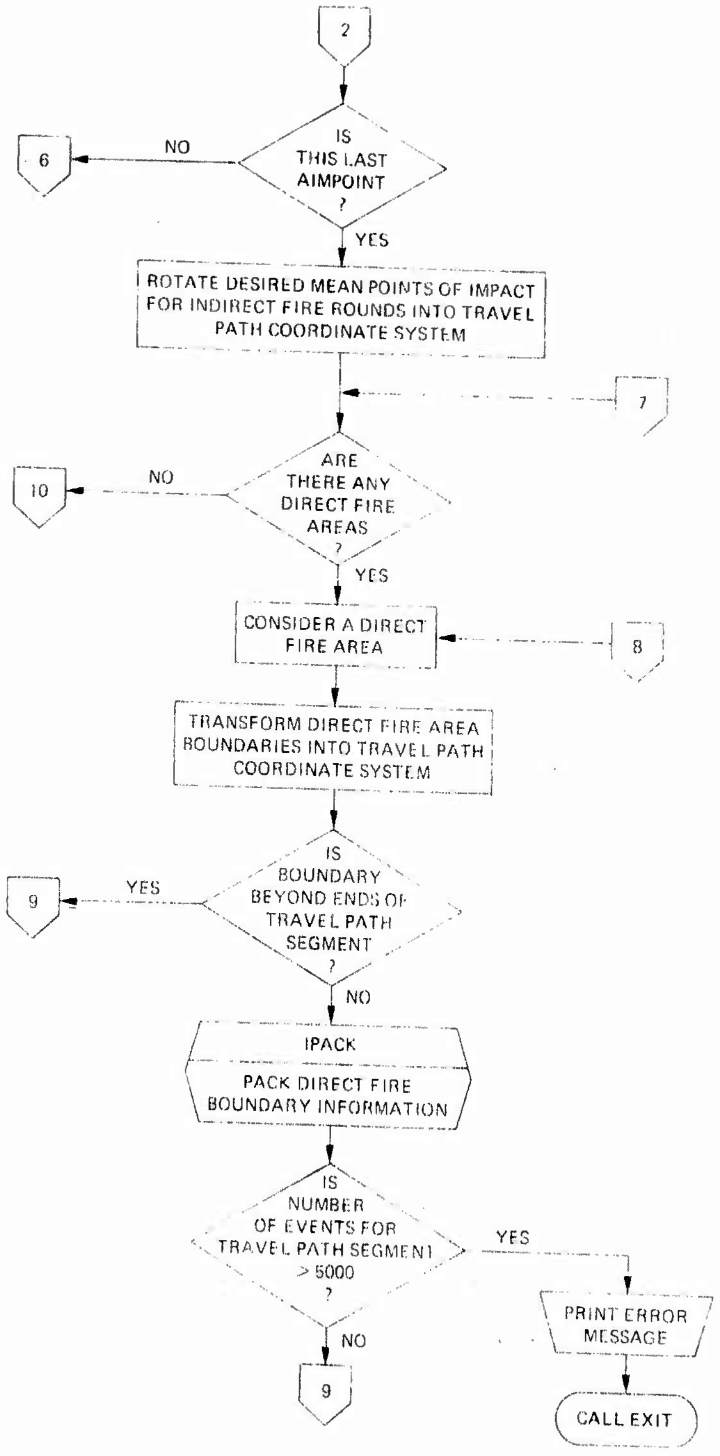

2
IS THIS LAST AIMPOINT ?
NO
6
YES
ROTATE DESIRED MEAN POINTS OF IMPACT FOR INDIRECT FIRE ROUNDS INTO TRAVEL PATH COORDINATE SYSTEM
7
ARE THERE ANY DIRECT FIRE AREAS ?
NO
10
YES
CONSIDER A DIRECT FIRE AREA
8
TRANSFORM DIRECT FIRE AREA BOUNDARIES INTO TRAVEL PATH COORDINATE SYSTEM
IS BOUNDARY BEYOND ENDS OF TRAVEL PATH SEGMENT ?
YES
9
NO
IPACK
PACK DIRECT FIRE BOUNDARY INFORMATION
IS NUMBER OF EVENTS FOR TRAVEL PATH SEGMENT > 5000 ?
YES
PRINT ERROR MESSAGE
CALL EXIT
NO
9

Figure 7. (Continued)

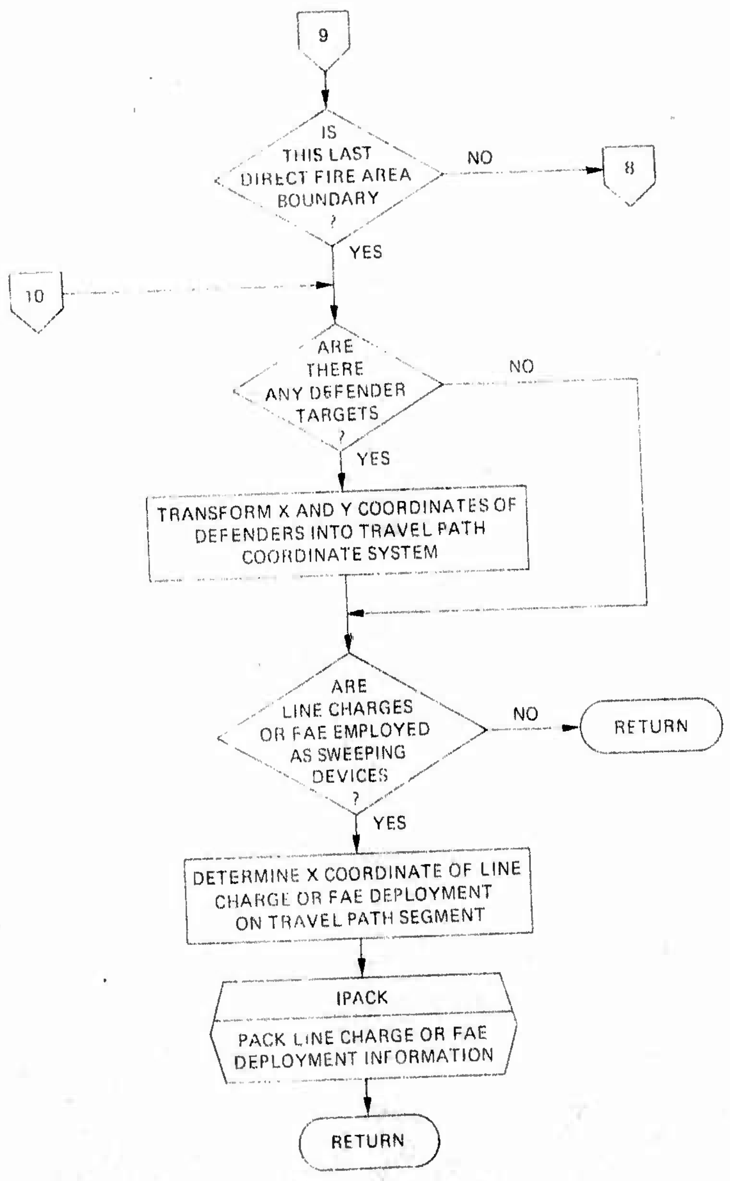

9
IS THIS LAST DIRECT FIRE AREA BOUNDARY ?
NO
8
YES
10
ARE THERE ANY DEFENDER TARGETS ?
NO
YES
TRANSFORM X AND Y COORDINATES OF DEFENDERS INTO TRAVEL PATH COORDINATE SYSTEM
ARE LINE CHARGES OR FAE EMPLOYED AS SWEEPING DEVICES ?
NO
RETURN
YES
DETERMINE X COORDINATE OF LINE CHARGE OR FAE DEPLOYMENT ON TRAVEL PATH SEGMENT
IPACK
PACK LINE CHARGE OR FAE DEPLOYMENT INFORMATION
RETURN

Figure 7. (Concluded)

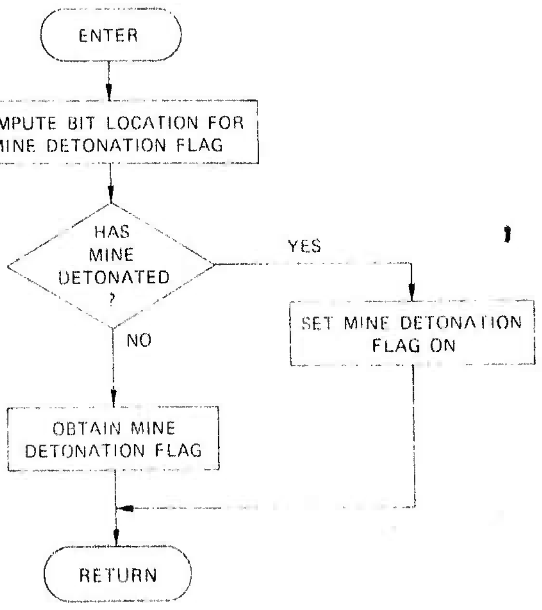

ENTER
COMPUTE BIT LOCATION FOR MINE DETONATION FLAG
HAS MINE DETONATED ?
YES
NO
SET MINE DETONATION FLAG ON
OBTAIN MINE DETONATION FLAG
RETURN

Figure 8. Flowchart, Subroutine BOOM

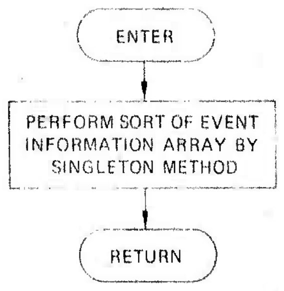


Figure 9. Flowchart, Subroutine SORT

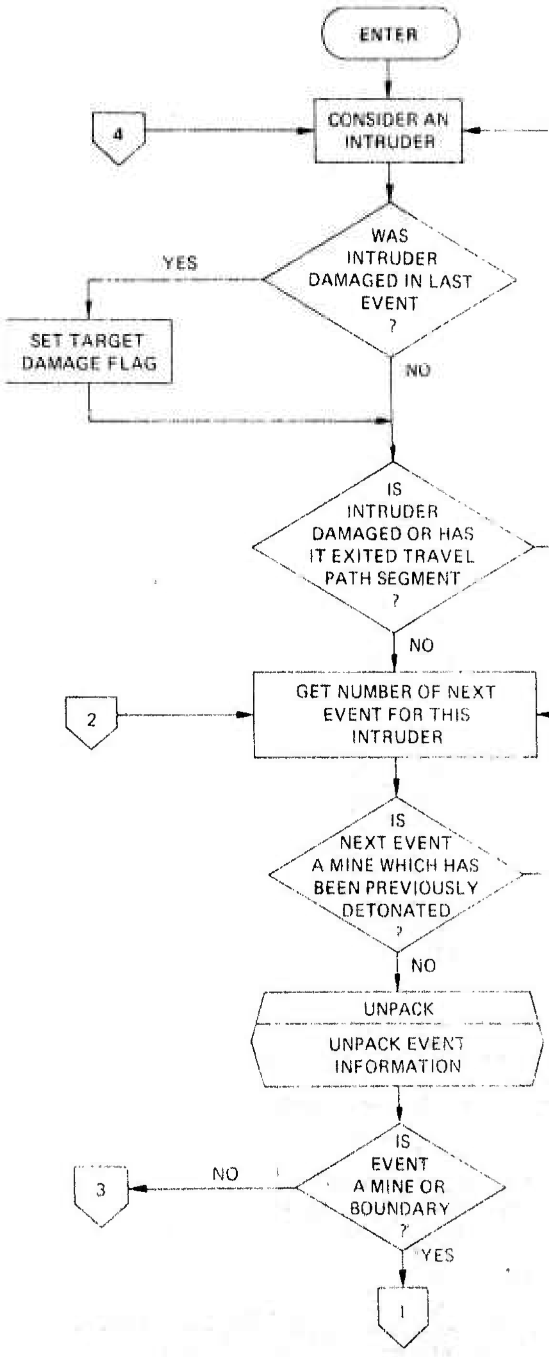

ENTER
CONSIDER AN INTRUDER
4
WAS INTRUDER DAMAGED IN LAST EVENT ?
YES
SET TARGET DAMAGE FLAG
NO
IS INTRUDER DAMAGED OR HAS IT EXITED TRAVEL PATH SEGMENT ?
YES
NO
GET NUMBER OF NEXT EVENT FOR THIS INTRUDER
2
IS NEXT EVENT A MINE WHICH HAS BEEN PREVIOUSLY DETONATED ?
YES
NO
UNPACK
UNPACK EVENT INFORMATION
IS EVENT A MINE OR BOUNDARY ?
NO
3
YES
1

Figure 10. Flowchart, Subroutine LOOPS

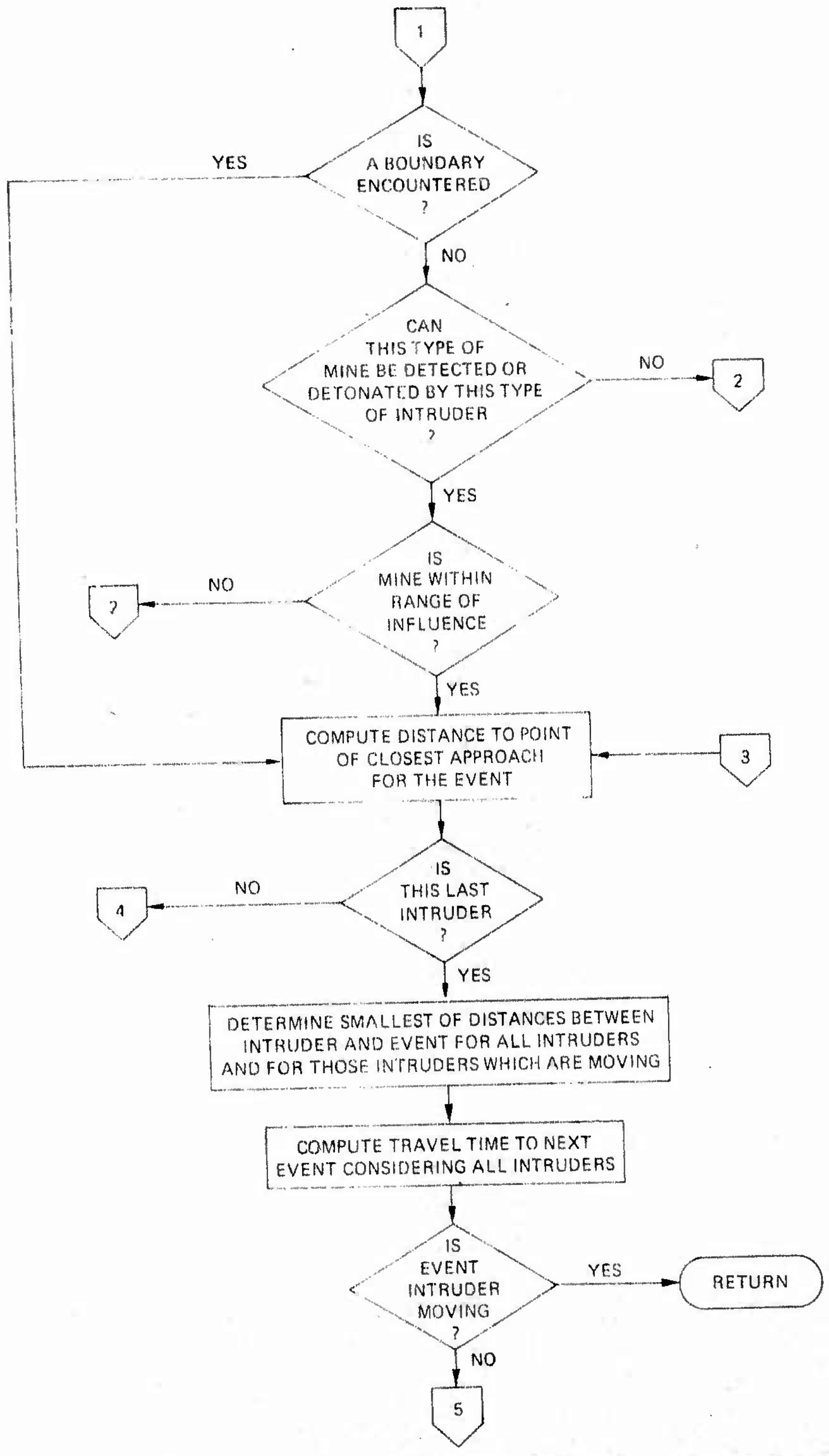
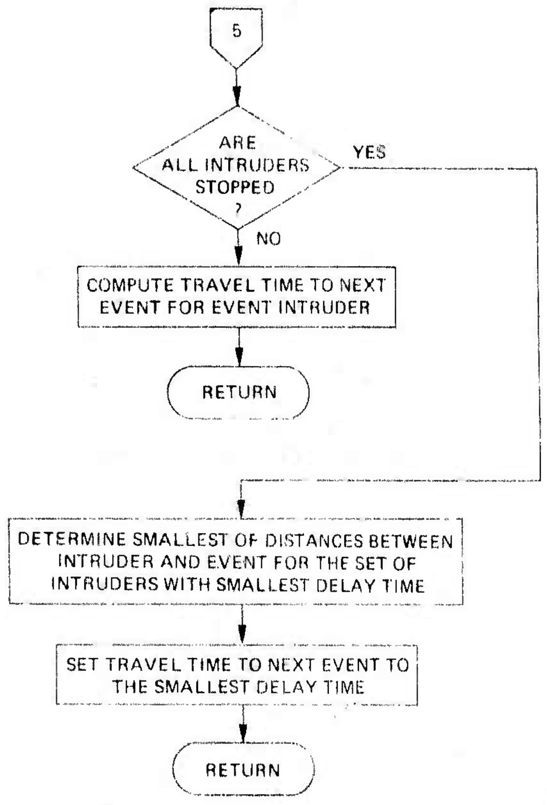

1
IS A BOUNDARY ENCOUNTERED ?
YES
NO
CAN THIS TYPE OF MINE BE DETECTED OR DETONATED BY THIS TYPE OF INTRUDER ?
NO
2
YES
IS MINE WITHIN RANGE OF INFLUENCE ?
NO
2
YES
COMPUTE DISTANCE TO POINT OF CLOSEST APPROACH FOR THE EVENT
3
IS THIS LAST INTRUDER ?
NO
4
YES
DETERMINE SMALLEST OF DISTANCES BETWEEN INTRUDER AND EVENT FOR ALL INTRUDERS AND FOR THOSE INTRUDERS WHICH ARE MOVING
COMPUTE TRAVEL TIME TO NEXT EVENT CONSIDERING ALL INTRUDERS
IS EVENT INTRUDER MOVING ?
YES
RETURN
NO
5

Figure 10. (Continued)



5
ARE ALL INTRUDERS STOPPED ?
YES
NO
COMPUTE TRAVEL TIME TO NEXT EVENT FOR EVENT INTRUDER
RETURN
DETERMINE SMALLEST OF DISTANCES BETWEEN INTRUDER AND EVENT FOR THE SET OF INTRUDERS WITH SMALLEST DELAY TIME
SET TRAVEL TIME TO NEXT EVENT TO THE SMALLEST DELAY TIME
RETURN

Figure 10. (Concluded)

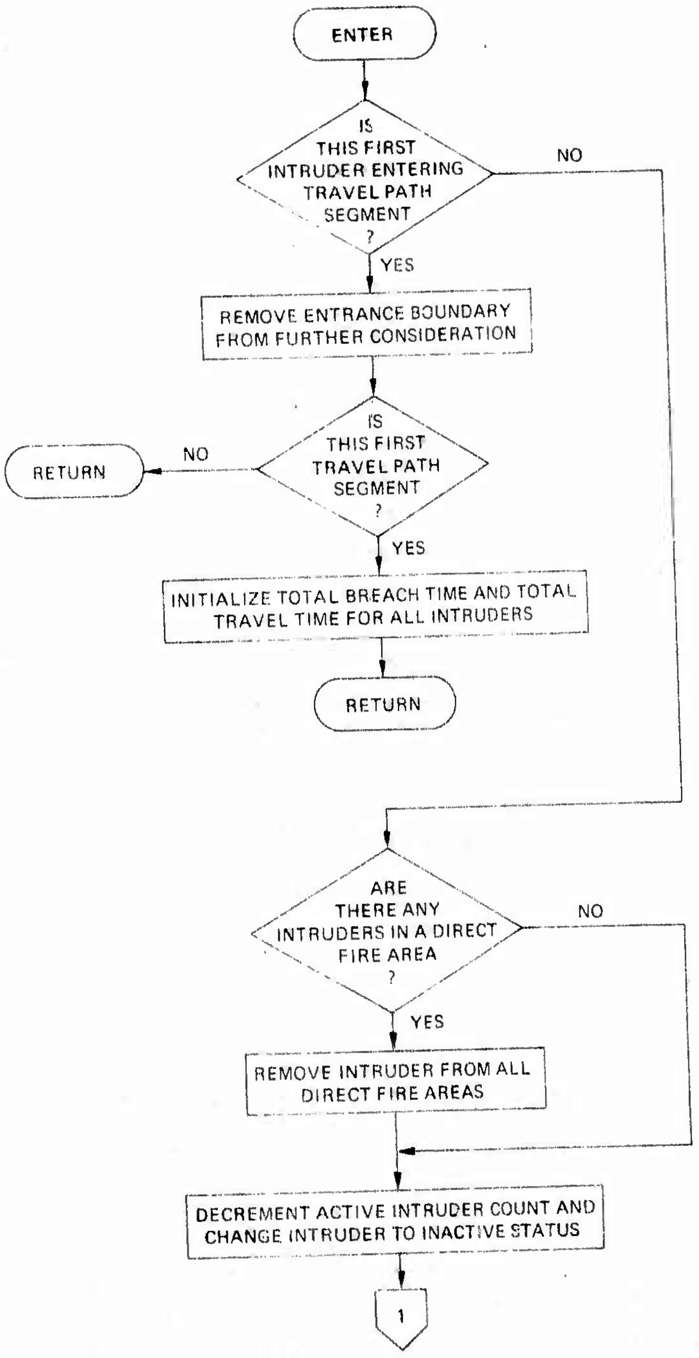

ENTER
IS THIS FIRST INTRUDER ENTERING TRAVEL PATH SEGMENT ?
NO
YES
REMOVE ENTRANCE BOUNDARY FROM FURTHER CONSIDERATION
IS THIS FIRST TRAVEL PATH SEGMENT ?
NO
RETURN
YES
INITIALIZE TOTAL BREACH TIME AND TOTAL TRAVEL TIME FOR ALL INTRUDERS
RETURN
ARE THERE ANY INTRUDERS IN A DIRECT FIRE AREA ?
NO
YES
REMOVE INTRUDER FROM ALL DIRECT FIRE AREAS
DECREMENT ACTIVE INTRUDER COUNT AND CHANGE INTRUDER TO INACTIVE STATUS
1

Figure 11. Flowchart, Subroutine EVENTC

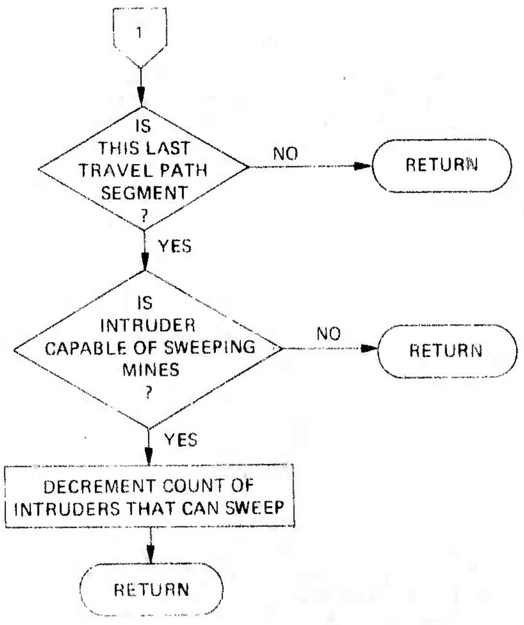

1
IS THIS LAST TRAVEL PATH SEGMENT ?
NO
RETURN
YES
IS INTRUDER CAPABLE OF SWEEPING MINES ?
NO
RETURN
YES
DECREMENT COUNT OF INTRUDERS THAT CAN SWEEP
RETURN

Figure 11. (Concluded)

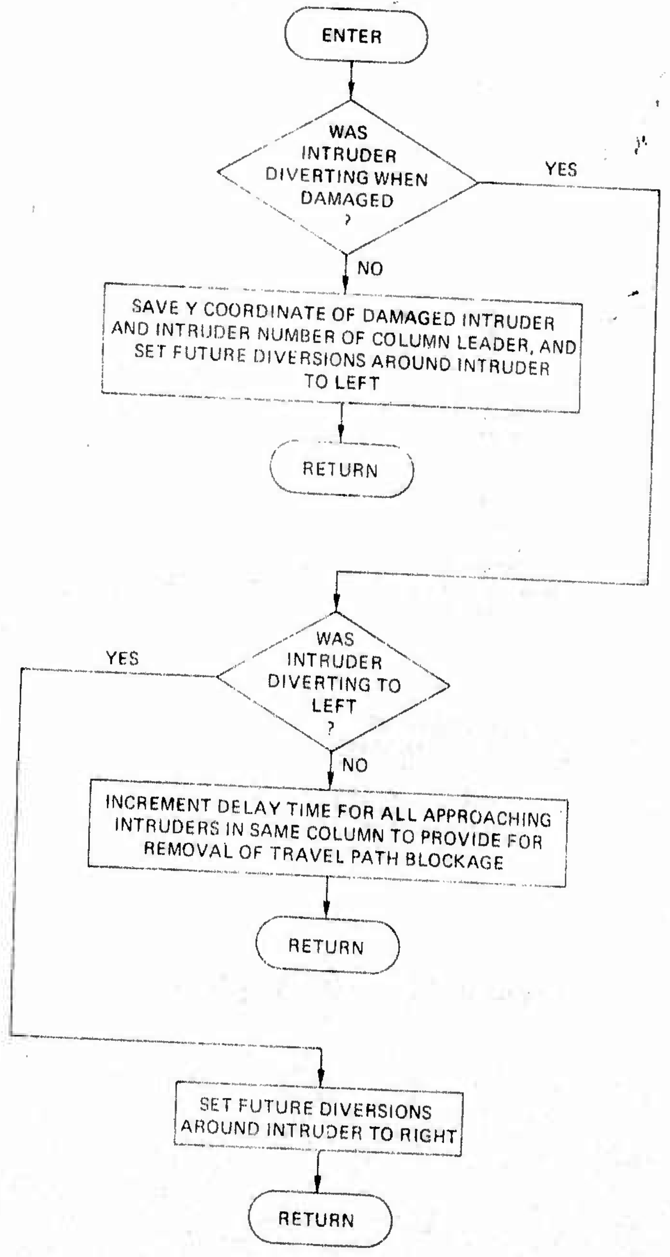

ENTER
WAS INTRUDER DIVERTING WHEN DAMAGED ?
YES
NO
SAVE Y COORDINATE OF DAMAGED INTRUDER AND INTRUDER NUMBER OF COLUMN LEADER, AND SET FUTURE DIVERSIONS AROUND INTRUDER TO LEFT
RETURN
WAS INTRUDER DIVERTING TO LEFT ?
YES
NO
INCREMENT DELAY TIME FOR ALL APPROACHING INTRUDERS IN SAME COLUMN TO PROVIDE FOR REMOVAL OF TRAVEL PATH BLOCKAGE
RETURN
SET FUTURE DIVERSIONS AROUND INTRUDER TO RIGHT
RETURN

Figure 12. Flowchart, Subroutine DIVSET

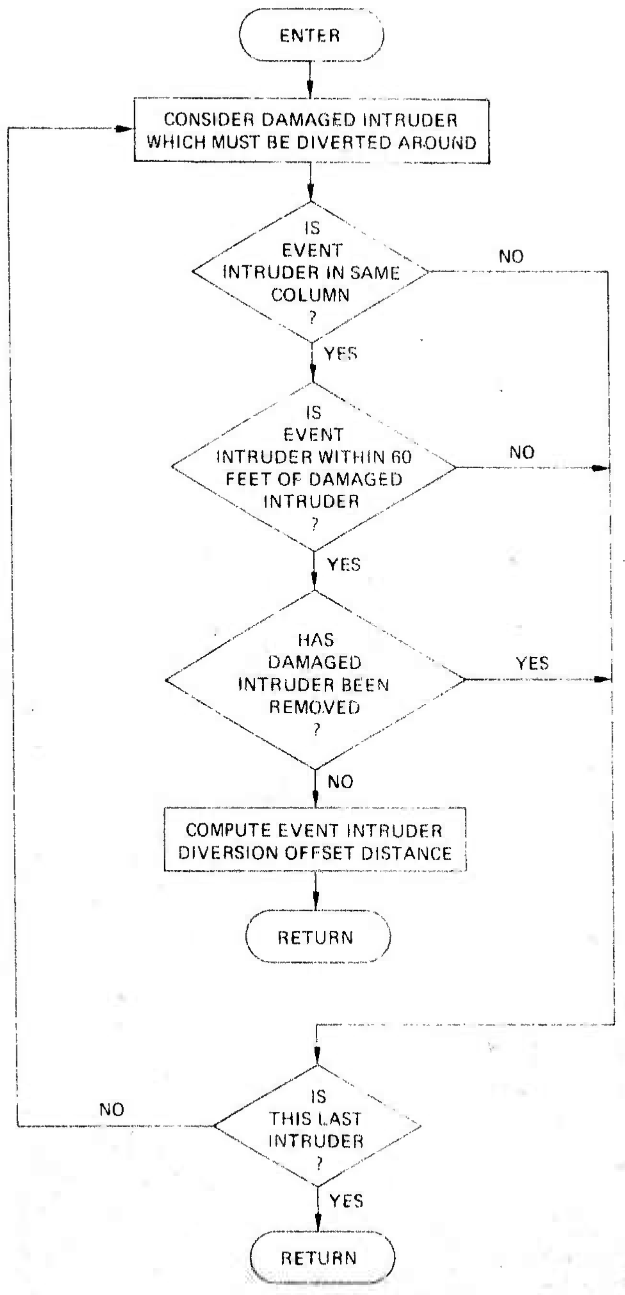

ENTER
CONSIDER DAMAGED INTRUDER WHICH MUST BE DIVERTED AROUND
IS EVENT INTRUDER IN SAME COLUMN ?
NO
YES
IS EVENT INTRUDER WITHIN 60 FEET OF DAMAGED INTRUDER ?
NO
YES
HAS DAMAGED INTRUDER BEEN REMOVED ?
YES
NO
COMPUTE EVENT INTRUDER DIVERSION OFFSET DISTANCE
RETURN
NO
IS THIS LAST INTRUDER ?
YES
RETURN

Figure 13. Flowchart, Subroutine DIVCHK

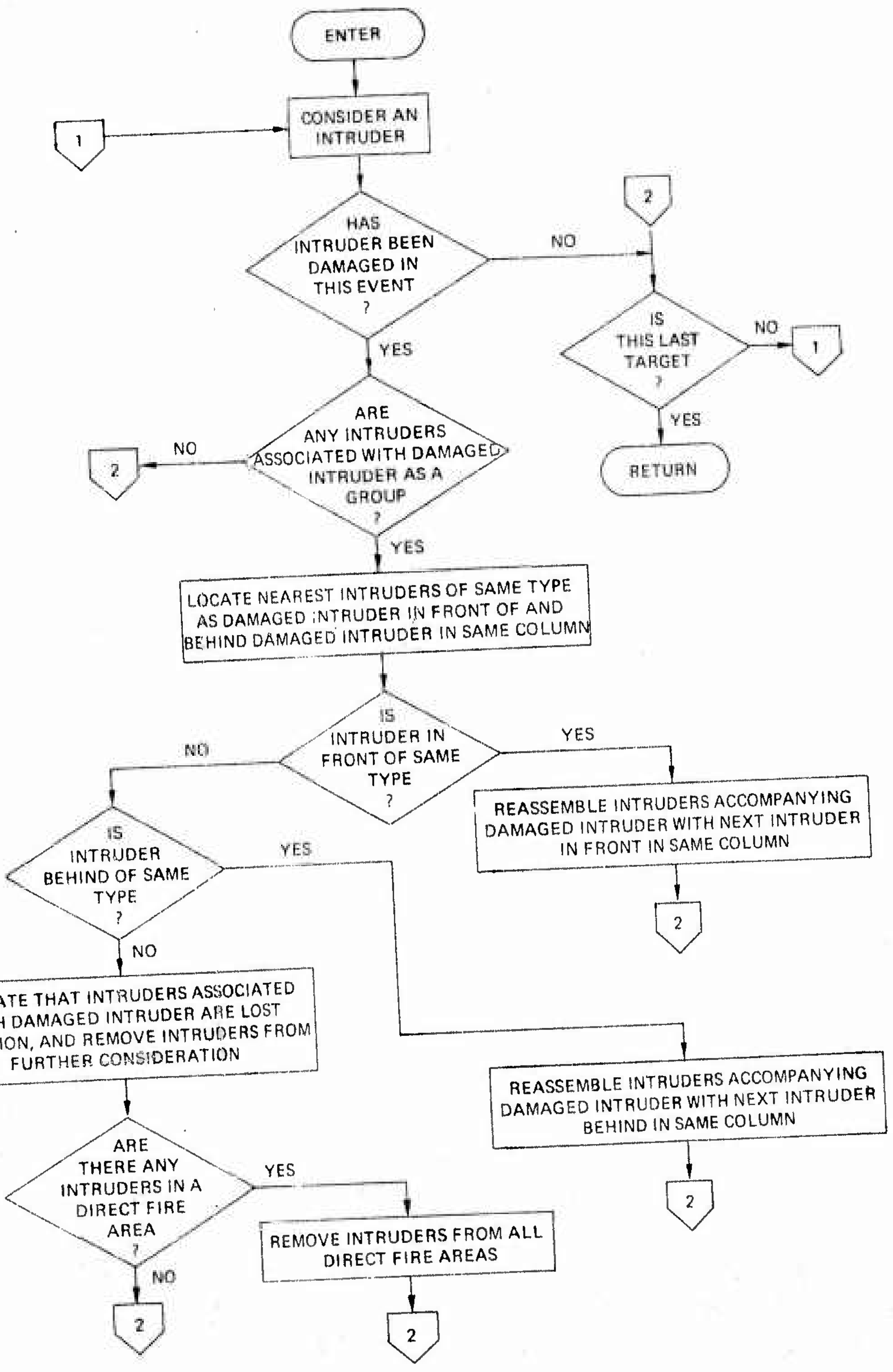

ENTER
CONSIDER AN INTRUDER
1
HAS INTRUDER BEEN DAMAGED IN THIS EVENT ?
NO
2
IS THIS LAST TARGET ?
NO
1
YES
RETURN
YES
ARE ANY INTRUDERS ASSOCIATED WITH DAMAGED INTRUDER AS A GROUP ?
NO
2
YES
LOCATE NEAREST INTRUDERS OF SAME TYPE AS DAMAGED INTRUDER IN FRONT OF AND BEHIND DAMAGED INTRUDER IN SAME COLUMN
IS INTRUDER IN FRONT OF SAME TYPE ?
YES
REASSEMBLE INTRUDERS ACCOMPANYING DAMAGED INTRUDER WITH NEXT INTRUDER IN FRONT IN SAME COLUMN
2
NO
IS INTRUDER BEHIND OF SAME TYPE ?
YES
REASSEMBLE INTRUDERS ACCOMPANYING DAMAGED INTRUDER WITH NEXT INTRUDER BEHIND IN SAME COLUMN
2
NO
INDICATE THAT INTRUDERS ASSOCIATED WITH DAMAGED INTRUDER ARE LOST TO MISSION, AND REMOVE INTRUDERS FROM FURTHER CONSIDERATION
ARE THERE ANY INTRUDERS IN A DIRECT FIRE AREA ?
YES
REMOVE INTRUDERS FROM ALL DIRECT FIRE AREAS
2
NO
2

Figure 14. Flowchart, Subroutine UNIT

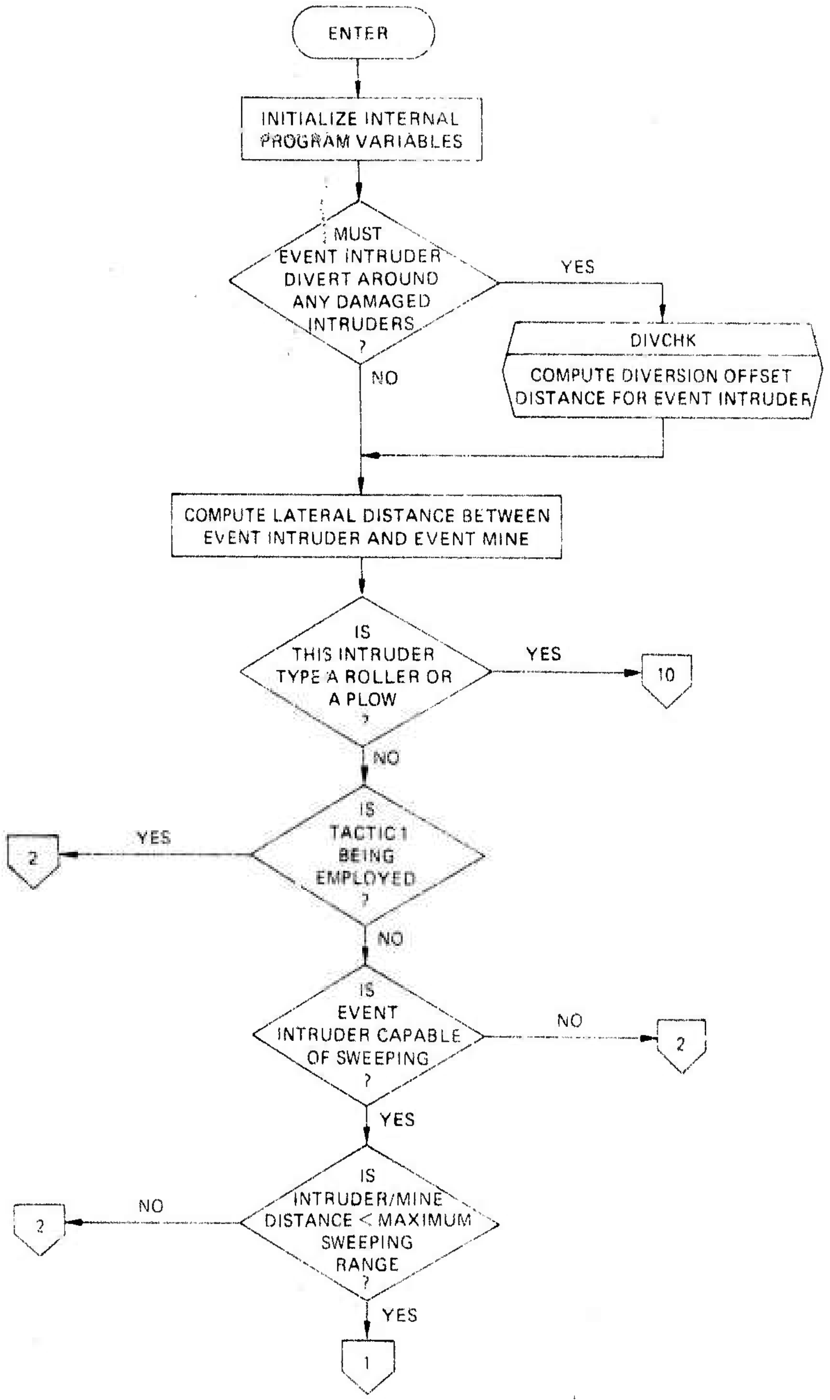
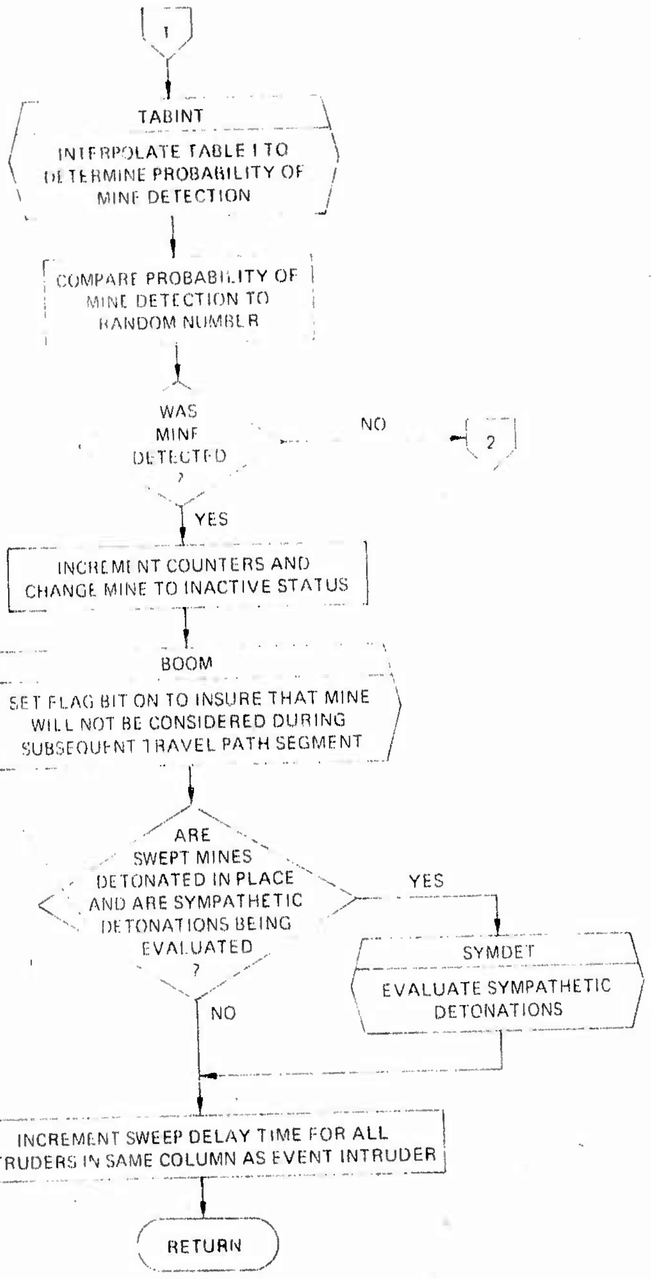

ENTER
INITIALIZE INTERNAL PROGRAM VARIABLES
MUST EVENT INTRUDER DIVERT AROUND ANY DAMAGED INTRUDERS ?
YES
DIVCHK
COMPUTE DIVERSION OFFSET DISTANCE FOR EVENT INTRUDER
NO
COMPUTE LATERAL DISTANCE BETWEEN EVENT INTRUDER AND EVENT MINE
IS THIS INTRUDER TYPE A ROLLER OR A PLOW ?
YES
10
NO
IS TACTIC 1 BEING EMPLOYED ?
YES
2
NO
IS EVENT INTRUDER CAPABLE OF SWEEPING ?
NO
2
YES
IS INTRUDER/MINE DISTANCE < MAXIMUM SWEEPING RANGE ?
NO
2
YES
1

Figure 15. Flowchart, Subroutine TGTMIN



1
TABINT
INTERPOLATE TABLE I TO DETERMINE PROBABILITY OF MINE DETECTION
COMPARE PROBABILITY OF MINE DETECTION TO RANDOM NUMBER
WAS MINE DETECTED ?
NO
2
YES
INCREMENT COUNTERS AND CHANGE MINE TO INACTIVE STATUS
BOOM
SET FLAG BIT ON TO INSURE THAT MINE WILL NOT BE CONSIDERED DURING SUBSEQUENT TRAVEL PATH SEGMENT
ARE SWEPT MINES DETONATED IN PLACE AND ARE SYMPATHETIC DETONATIONS BEING EVALUATED ?
YES
SYMDET
EVALUATE SYMPATHETIC DETONATIONS
NO
INCREMENT SWEEP DELAY TIME FOR ALL INTRUDERS IN SAME COLUMN AS EVENT INTRUDER
RETURN

Figure 15. (Continued)

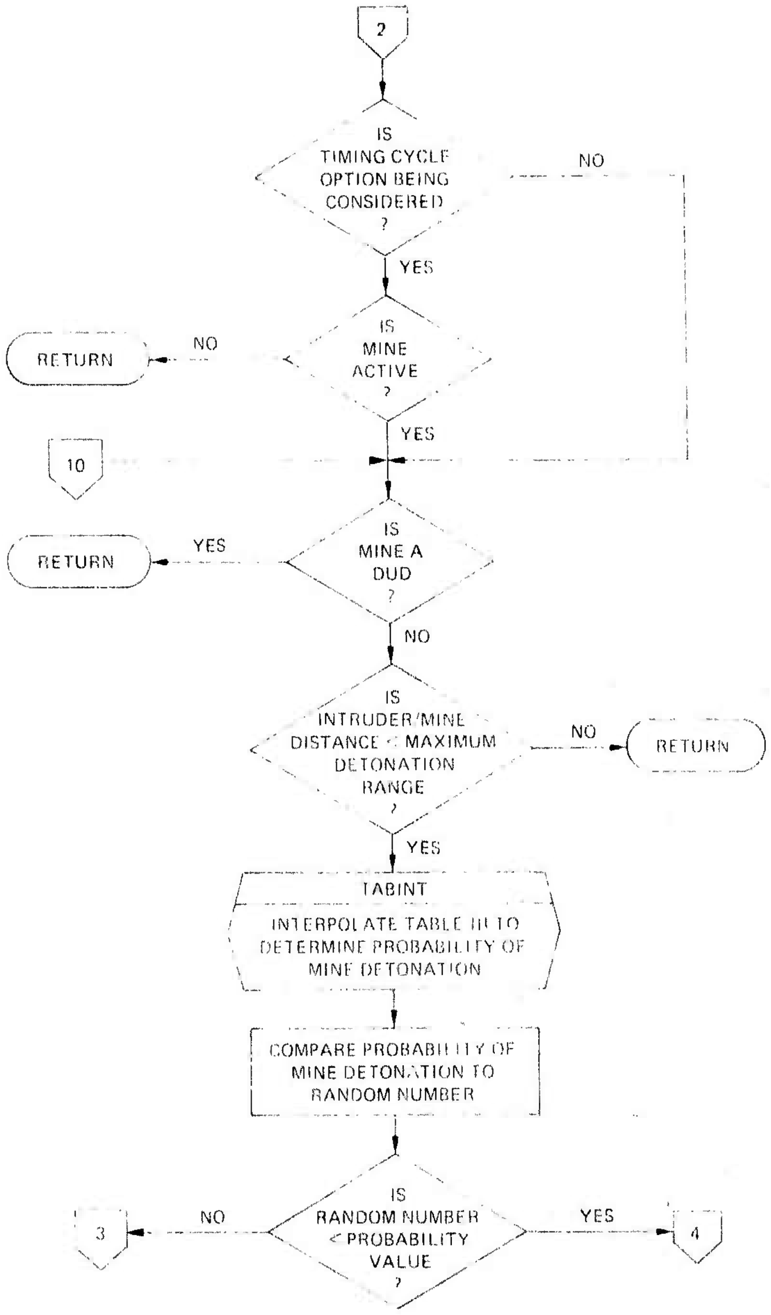

2
IS TIMING CYCLE OPTION BEING CONSIDERED ?
NO
YES
IS MINE ACTIVE ?
NO
RETURN
YES
10
IS MINE A DUD ?
YES
RETURN
NO
IS INTRUDER/MINE DISTANCE < MAXIMUM DETONATION RANGE ?
NO
RETURN
YES
TABINT
INTERPOLATE TABLE III TO DETERMINE PROBABILITY OF MINE DETONATION
COMPARE PROBABILITY OF MINE DETONATION TO RANDOM NUMBER
IS RANDOM NUMBER < PROBABILITY VALUE ?
NO
3
YES
4

Figure 15. (Continued)

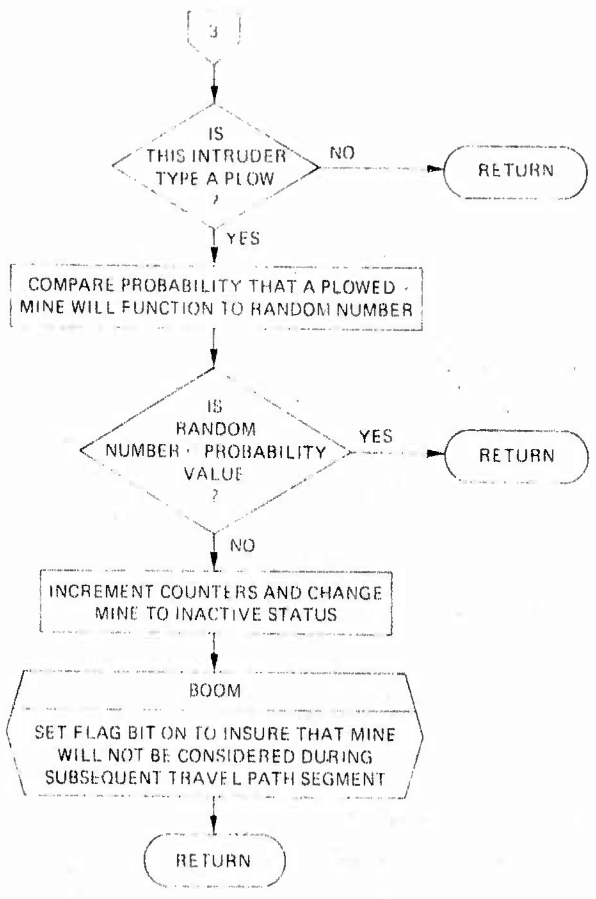

3
IS THIS INTRUDER TYPE A PLOW ?
NO
RETURN
YES
COMPARE PROBABILITY THAT A PLOWED MINE WILL FUNCTION TO RANDOM NUMBER
IS RANDOM NUMBER > PROBABILITY VALUE ?
YES
RETURN
NO
INCREMENT COUNTERS AND CHANGE MINE TO INACTIVE STATUS
BOOM
SET FLAG BIT ON TO INSURE THAT MINE WILL NOT BE CONSIDERED DURING SUBSEQUENT TRAVEL PATH SEGMENT
RETURN

Figure 15. (Continued)

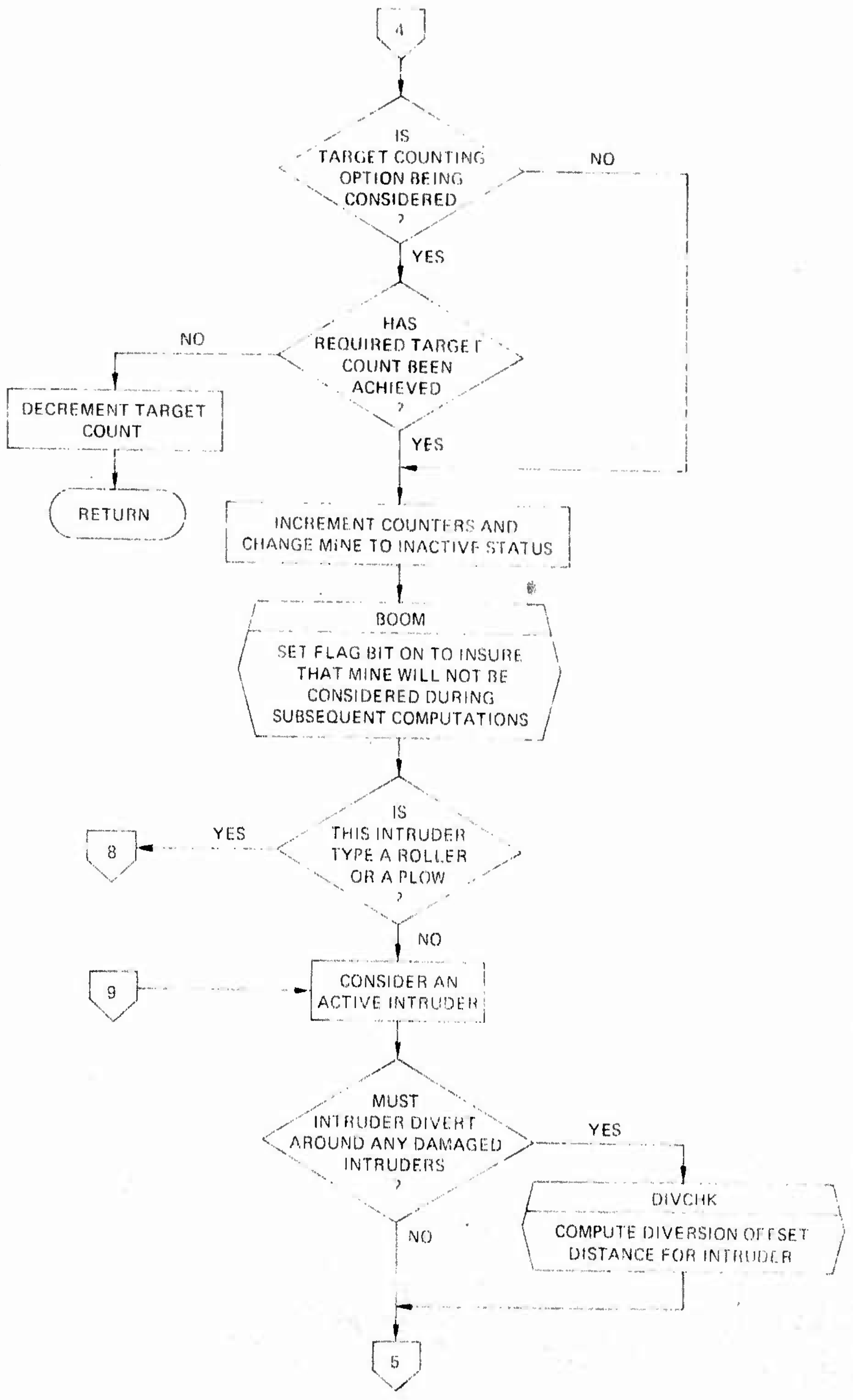

4
IS TARGET COUNTING OPTION BEING CONSIDERED ?
NO
YES
HAS REQUIRED TARGET COUNT BEEN ACHIEVED ?
NO
DECREMENT TARGET COUNT
RETURN
YES
INCREMENT COUNTERS AND CHANGE MINE TO INACTIVE STATUS
BOOM
SET FLAG BIT ON TO INSURE THAT MINE WILL NOT BE CONSIDERED DURING SUBSEQUENT COMPUTATIONS
IS THIS INTRUDER TYPE A ROLLER OR A PLOW ?
YES
8
NO
9
CONSIDER AN ACTIVE INTRUDER
MUST INTRUDER DIVERT AROUND ANY DAMAGED INTRUDERS ?
YES
DIVCHK
COMPUTE DIVERSION OFFSET DISTANCE FOR INTRUDER
NO
5

Figure 15. (Continued)

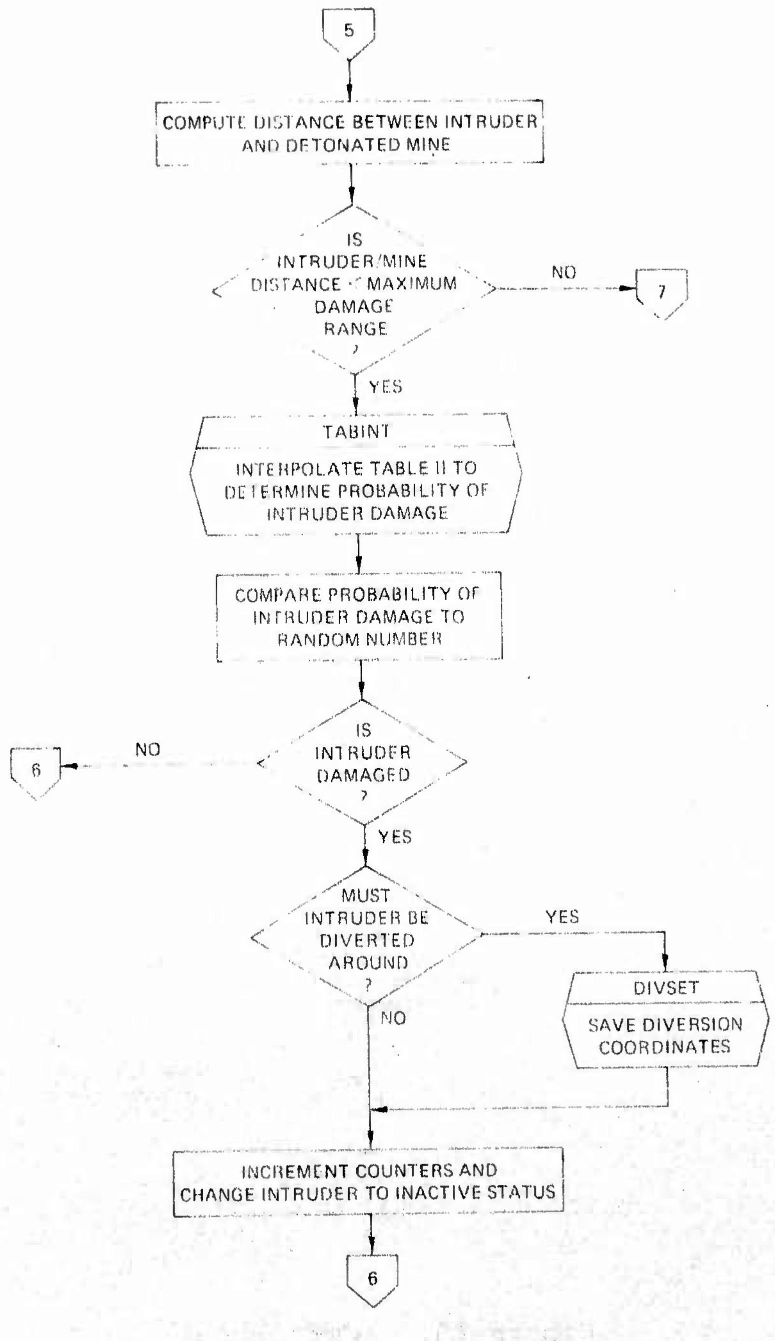

5
COMPUTE DISTANCE BETWEEN INTRUDER AND DETONATED MINE
IS INTRUDER/MINE DISTANCE < MAXIMUM DAMAGE RANGE ?
NO
7
YES
TABINT
INTERPOLATE TABLE II TO DETERMINE PROBABILITY OF INTRUDER DAMAGE
COMPARE PROBABILITY OF INTRUDER DAMAGE TO RANDOM NUMBER
IS INTRUDER DAMAGED ?
NO
6
YES
MUST INTRUDER BE DIVERTED AROUND ?
YES
DIVSET
SAVE DIVERSION COORDINATES
NO
INCREMENT COUNTERS AND CHANGE INTRUDER TO INACTIVE STATUS
6

Figure 15. (Continued)

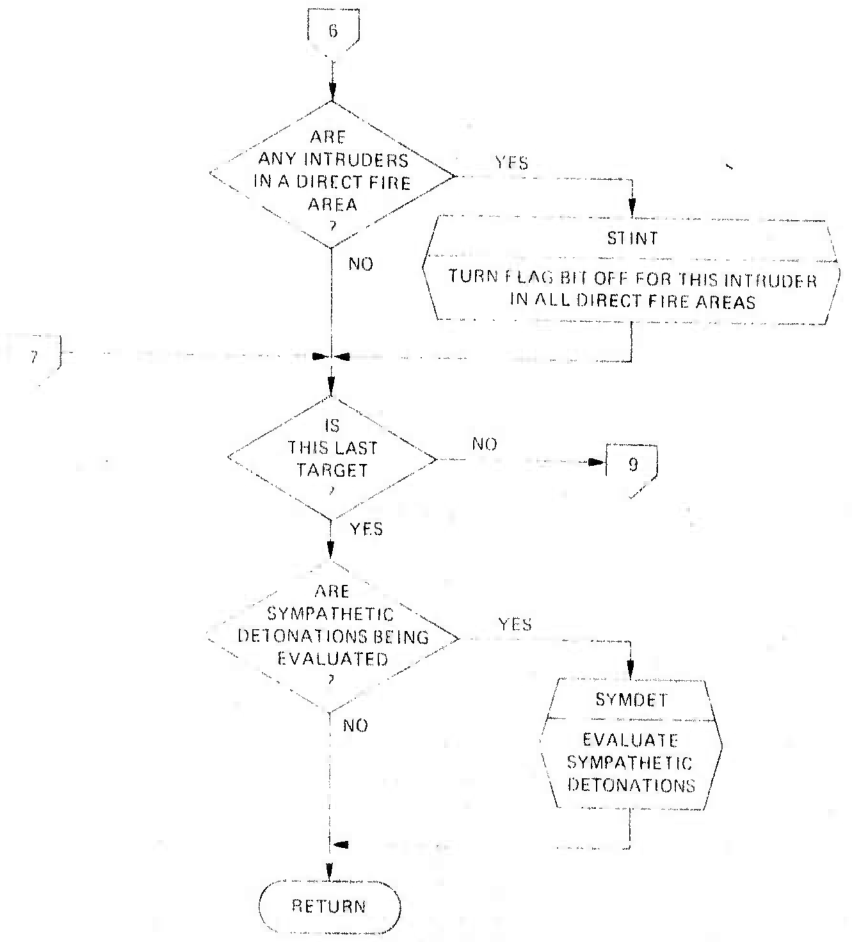
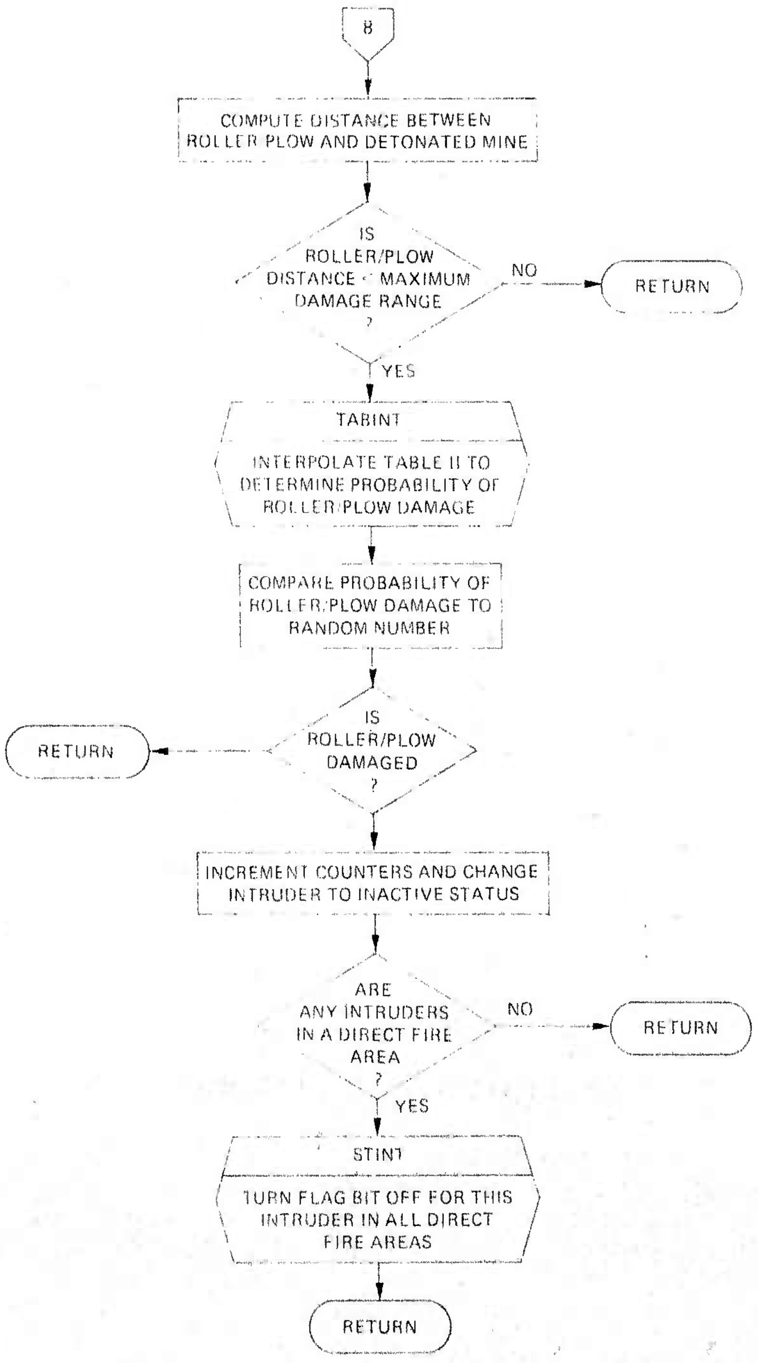
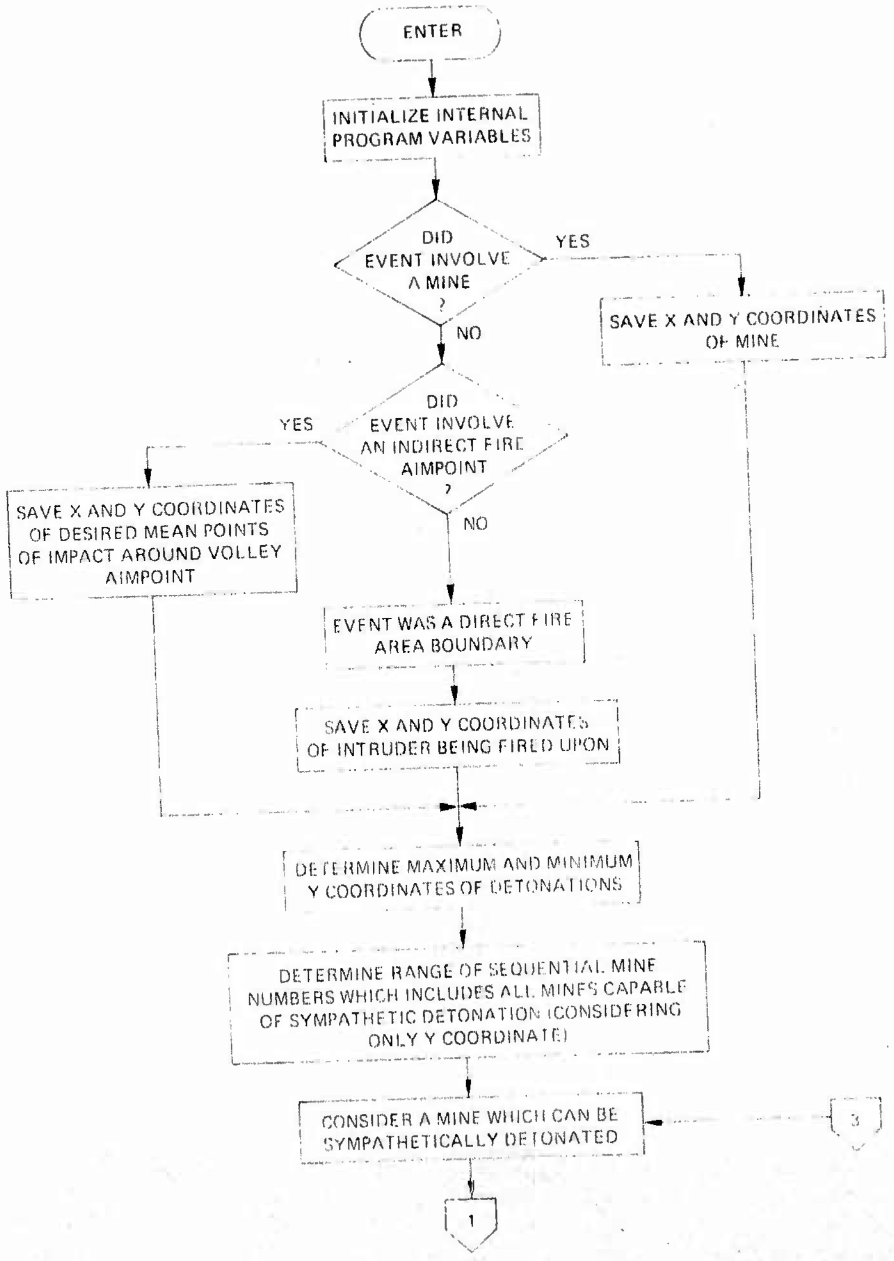

6
ARE ANY INTRUDERS IN A DIRECT FIRE AREA ?
YES
NO
STINT
TURN FLAG BIT OFF FOR THIS INTRUDER IN ALL DIRECT FIRE AREAS
7
IS THIS LAST TARGET ?
NO
9
YES
ARE SYMPATHETIC DETONATIONS BEING EVALUATED ?
YES
NO
SYMDET
EVALUATE SYMPATHETIC DETONATIONS
RETURN

Figure 15. (Continued)



8
COMPUTE DISTANCE BETWEEN ROLLER PLOW AND DETONATED MINE
IS ROLLER/PLOW DISTANCE < MAXIMUM DAMAGE RANGE ?
NO
RETURN
YES
TABINT
INTERPOLATE TABLE II TO DETERMINE PROBABILITY OF ROLLER/PLOW DAMAGE
COMPARE PROBABILITY OF ROLLER/PLOW DAMAGE TO RANDOM NUMBER
IS ROLLER/PLOW DAMAGED ?
RETURN
INCREMENT COUNTERS AND CHANGE INTRUDER TO INACTIVE STATUS
ARE ANY INTRUDERS IN A DIRECT FIRE AREA ?
NO
RETURN
YES
STINT
TURN FLAG BIT OFF FOR THIS INTRUDER IN ALL DIRECT FIRE AREAS
RETURN

Figure 15. (Concluded)



ENTER
INITIALIZE INTERNAL PROGRAM VARIABLES
DID EVENT INVOLVE A MINE ?
YES
NO
SAVE X AND Y COORDINATES OF MINE
DID EVENT INVOLVE AN INDIRECT FIRE AIMPOINT ?
YES
NO
SAVE X AND Y COORDINATES OF DESIRED MEAN POINTS OF IMPACT AROUND VOLLEY AIMPOINT
EVENT WAS A DIRECT FIRE AREA BOUNDARY
SAVE X AND Y COORDINATES OF INTRUDER BEING FIRED UPON
DETERMINE MAXIMUM AND MINIMUM Y COORDINATES OF DETONATIONS
DETERMINE RANGE OF SEQUENTIAL MINE NUMBERS WHICH INCLUDES ALL MINES CAPABLE OF SYMPATHETIC DETONATION (CONSIDERING ONLY Y COORDINATE)
CONSIDER A MINE WHICH CAN BE SYMPATHETICALLY DETONATED
3
1

Figure 16. Flowchart, Subroutine SYMDET

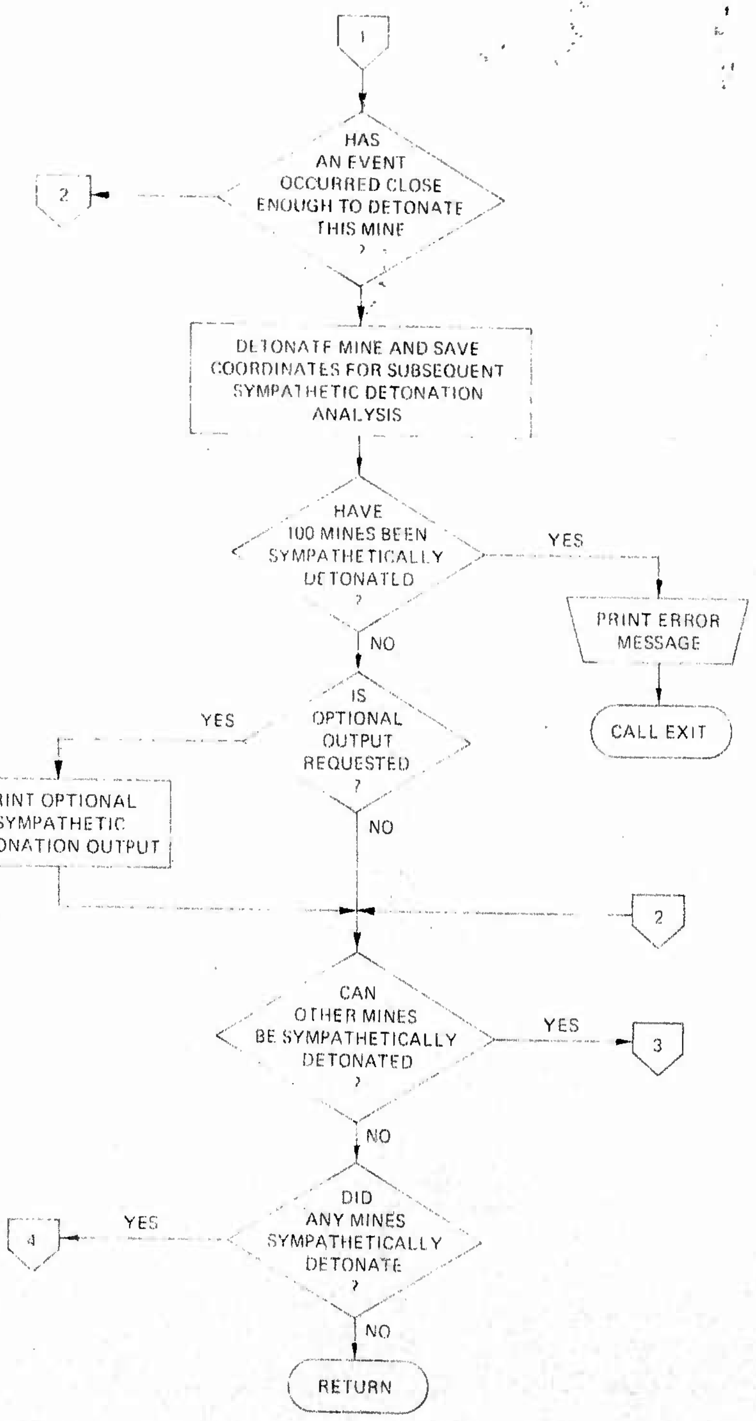

1
HAS AN EVENT OCCURRED CLOSE ENOUGH TO DETONATE THIS MINE ?
2
DETONATE MINE AND SAVE COORDINATES FOR SUBSEQUENT SYMPATHETIC DETONATION ANALYSIS
HAVE 100 MINES BEEN SYMPATHETICALLY DETONATED ?
YES
PRINT ERROR MESSAGE
CALL EXIT
NO
IS OPTIONAL OUTPUT REQUESTED ?
YES
PRINT OPTIONAL SYMPATHETIC DETONATION OUTPUT
NO
2
CAN OTHER MINES BE SYMPATHETICALLY DETONATED ?
YES
3
NO
DID ANY MINES SYMPATHETICALLY DETONATE ?
YES
4
NO
RETURN

Figure 16. (Concluded)

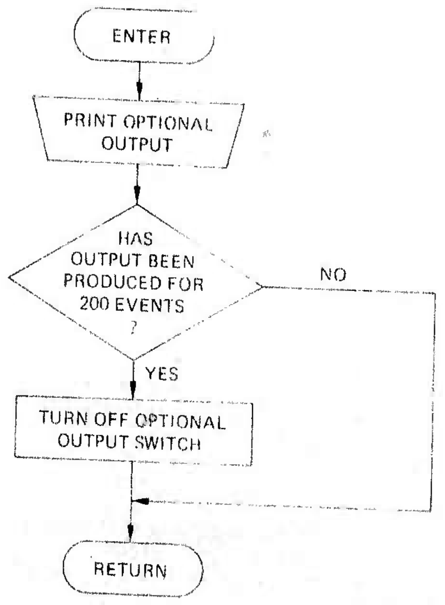

ENTER
PRINT OPTIONAL OUTPUT
HAS OUTPUT BEEN PRODUCED FOR 200 EVENTS ?
NO
YES
TURN OFF OPTIONAL OUTPUT SWITCH
RETURN

Figure 17. Flowchart, Subroutine PRINTO

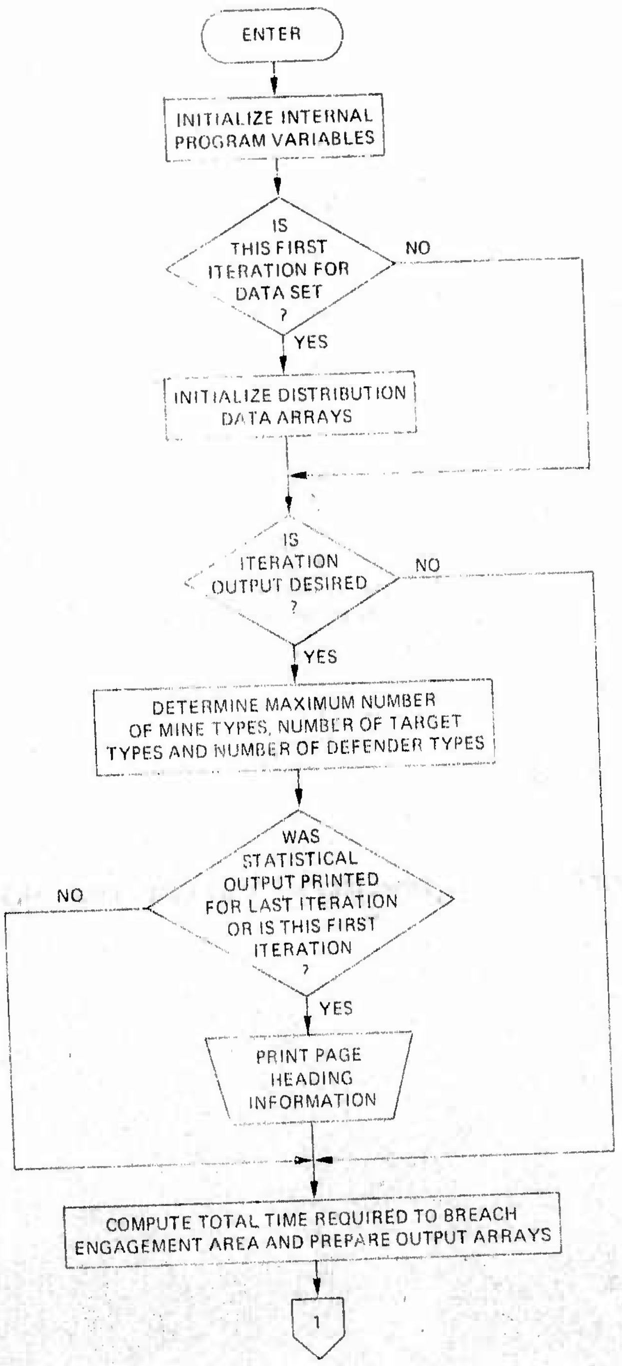

ENTER
INITIALIZE INTERNAL PROGRAM VARIABLES
IS THIS FIRST ITERATION FOR DATA SET ?
NO
YES
INITIALIZE DISTRIBUTION DATA ARRAYS
IS ITERATION OUTPUT DESIRED ?
NO
YES
DETERMINE MAXIMUM NUMBER OF MINE TYPES, NUMBER OF TARGET TYPES AND NUMBER OF DEFENDER TYPES
WAS STATISTICAL OUTPUT PRINTED FOR LAST ITERATION OR IS THIS FIRST ITERATION ?
NO
YES
PRINT PAGE HEADING INFORMATION
COMPUTE TOTAL TIME REQUIRED TO BREACH ENGAGEMENT AREA AND PREPARE OUTPUT ARRAYS
1

Figure 18. Flowchart, Subroutine PRINTR

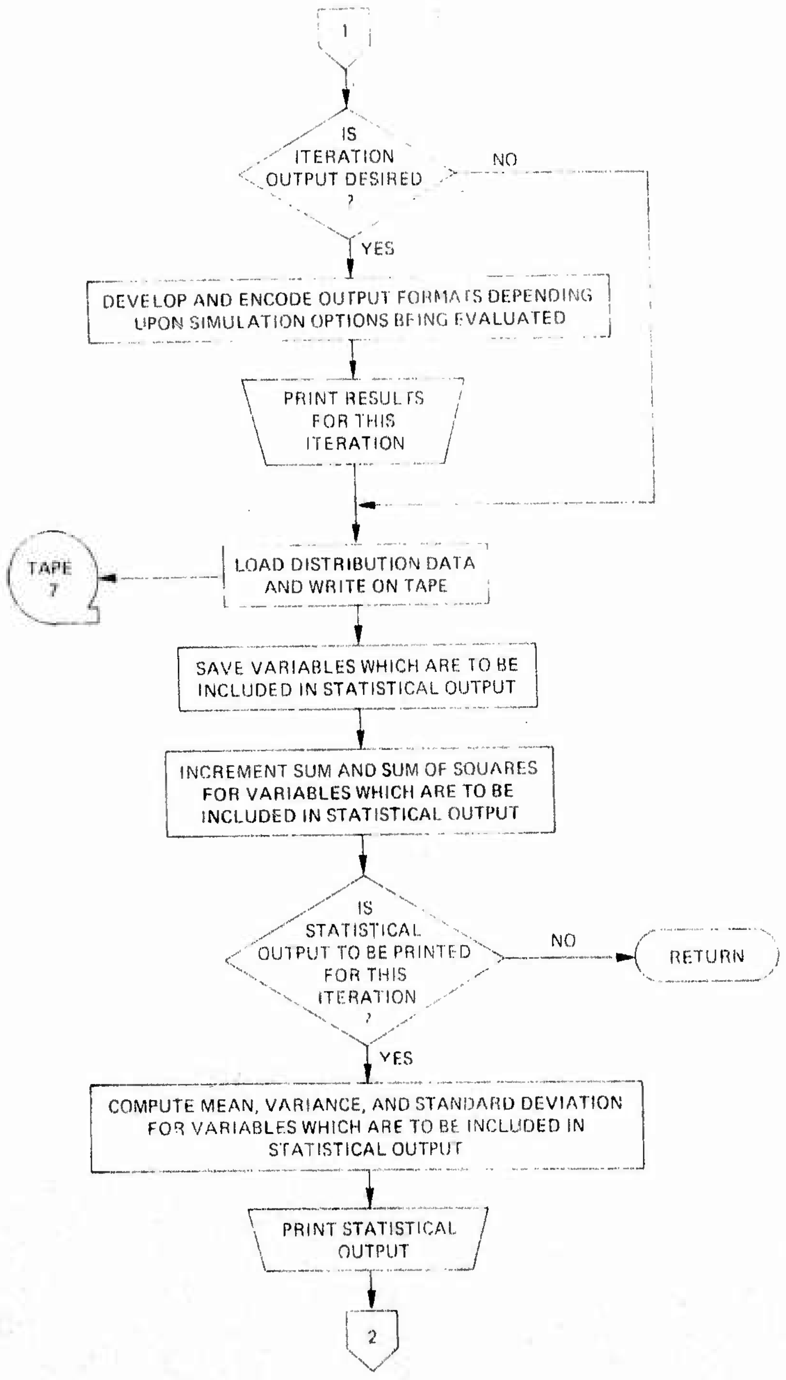

1
IS ITERATION OUTPUT DESIRED ?
NO
YES
DEVELOP AND ENCODE OUTPUT FORMATS DEPENDING UPON SIMULATION OPTIONS BEING EVALUATED
PRINT RESULTS FOR THIS ITERATION
TAPE 7
LOAD DISTRIBUTION DATA AND WRITE ON TAPE
SAVE VARIABLES WHICH ARE TO BE INCLUDED IN STATISTICAL OUTPUT
INCREMENT SUM AND SUM OF SQUARES FOR VARIABLES WHICH ARE TO BE INCLUDED IN STATISTICAL OUTPUT
IS STATISTICAL OUTPUT TO BE PRINTED FOR THIS ITERATION ?
NO
RETURN
YES
COMPUTE MEAN, VARIANCE, AND STANDARD DEVIATION FOR VARIABLES WHICH ARE TO BE INCLUDED IN STATISTICAL OUTPUT
PRINT STATISTICAL OUTPUT
2

Figure 18. (Continued)

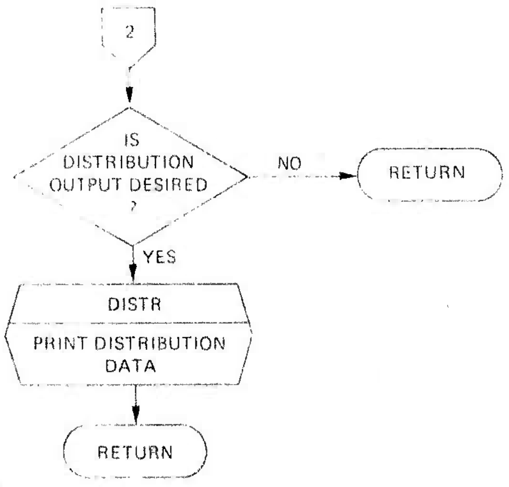


Figure 18. (Concluded)

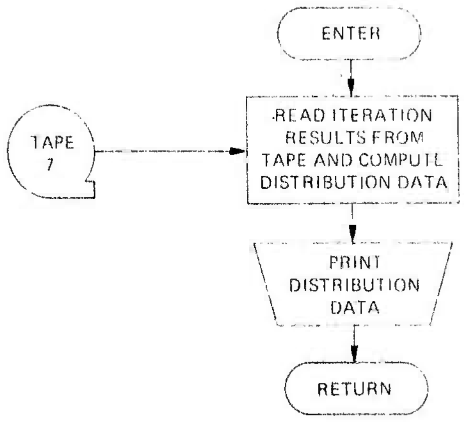

ENTER
READ ITERATION RESULTS FROM TAPE AND COMPUTE DISTRIBUTION DATA
TAPE 7
PRINT DISTRIBUTION DATA
RETURN

Figure 19. Flowchart, Subroutine DISTR

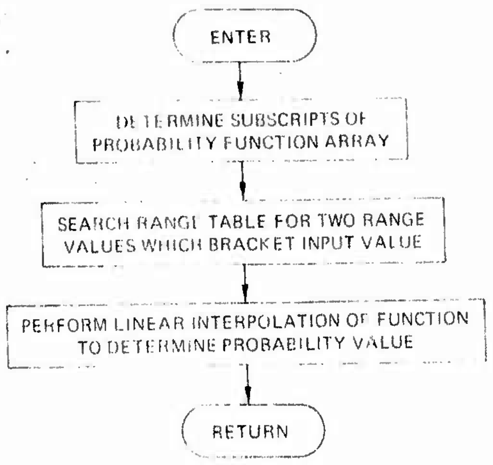

ENTER
DETERMINE SUBSCRIPTS OF PROBABILITY FUNCTION ARRAY
SEARCH RANGE TABLE FOR TWO RANGE VALUES WHICH BRACKET INPUT VALUE
PERFORM LINEAR INTERPOLATION OF FUNCTION TO DETERMINE PROBABILITY VALUE
RETURN

Figure 20. Flowchart, Subroutine TABINT

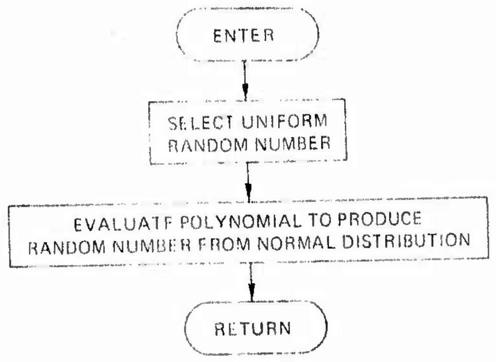

ENTER
SELECT UNIFORM RANDOM NUMBER
EVALUATE POLYNOMIAL TO PRODUCE RANDOM NUMBER FROM NORMAL DISTRIBUTION
RETURN

Figure 21. Flowchart, Subroutine RNORM

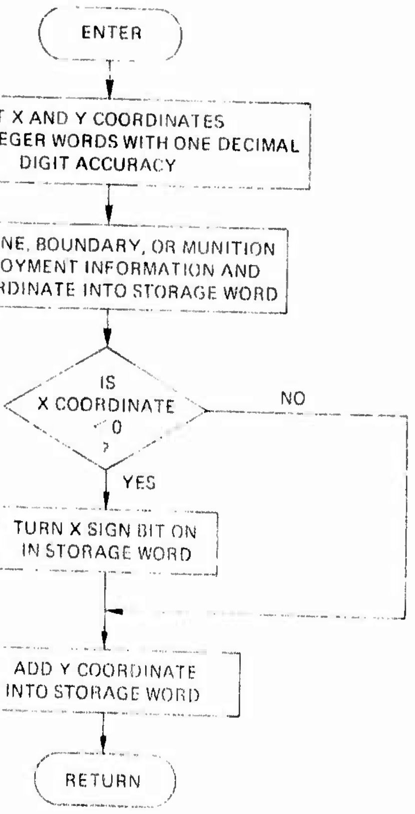

ENTER
PUT X AND Y COORDINATES INTO INTEGER WORDS WITH ONE DECIMAL DIGIT ACCURACY
PUT MINE, BOUNDARY, OR MUNITION DEPLOYMENT INFORMATION AND X COORDINATE INTO STORAGE WORD
IS X COORDINATE < 0 ?
NO
YES
TURN X SIGN BIT ON IN STORAGE WORD
ADD Y COORDINATE INTO STORAGE WORD
RETURN

Figure 22. Flowchart, Subroutine IPACK

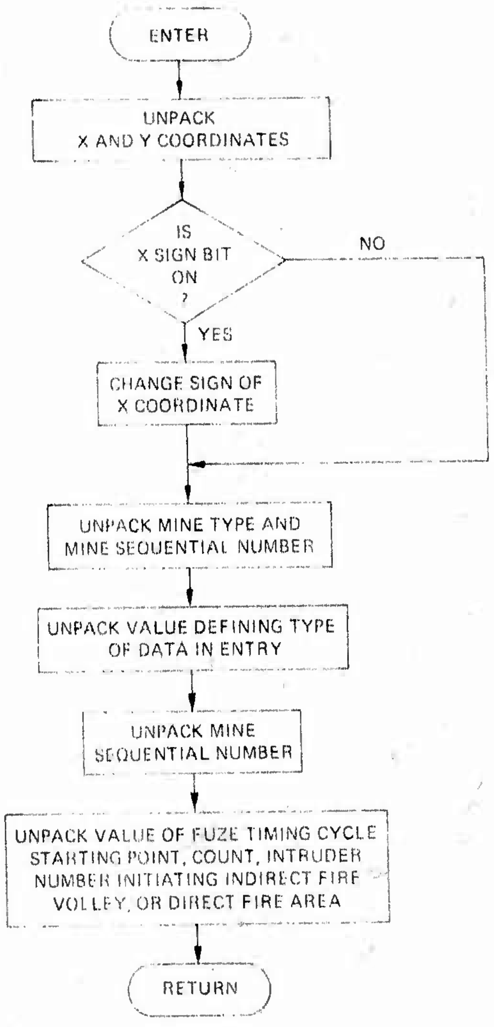

ENTER
UNPACK X AND Y COORDINATES
IS X SIGN BIT ON ?
NO
YES
CHANGE SIGN OF X COORDINATE
UNPACK MINE TYPE AND MINE SEQUENTIAL NUMBER
UNPACK VALUE DEFINING TYPE OF DATA IN ENTRY
UNPACK MINE SEQUENTIAL NUMBER
UNPACK VALUE OF FUZE TIMING CYCLE STARTING POINT, COUNT, INTRUDER NUMBER INITIATING INDIRECT FIRE VOLLEY, OR DIRECT FIRE AREA
RETURN

Figure 23. Flowchart, Subroutine UNPACK

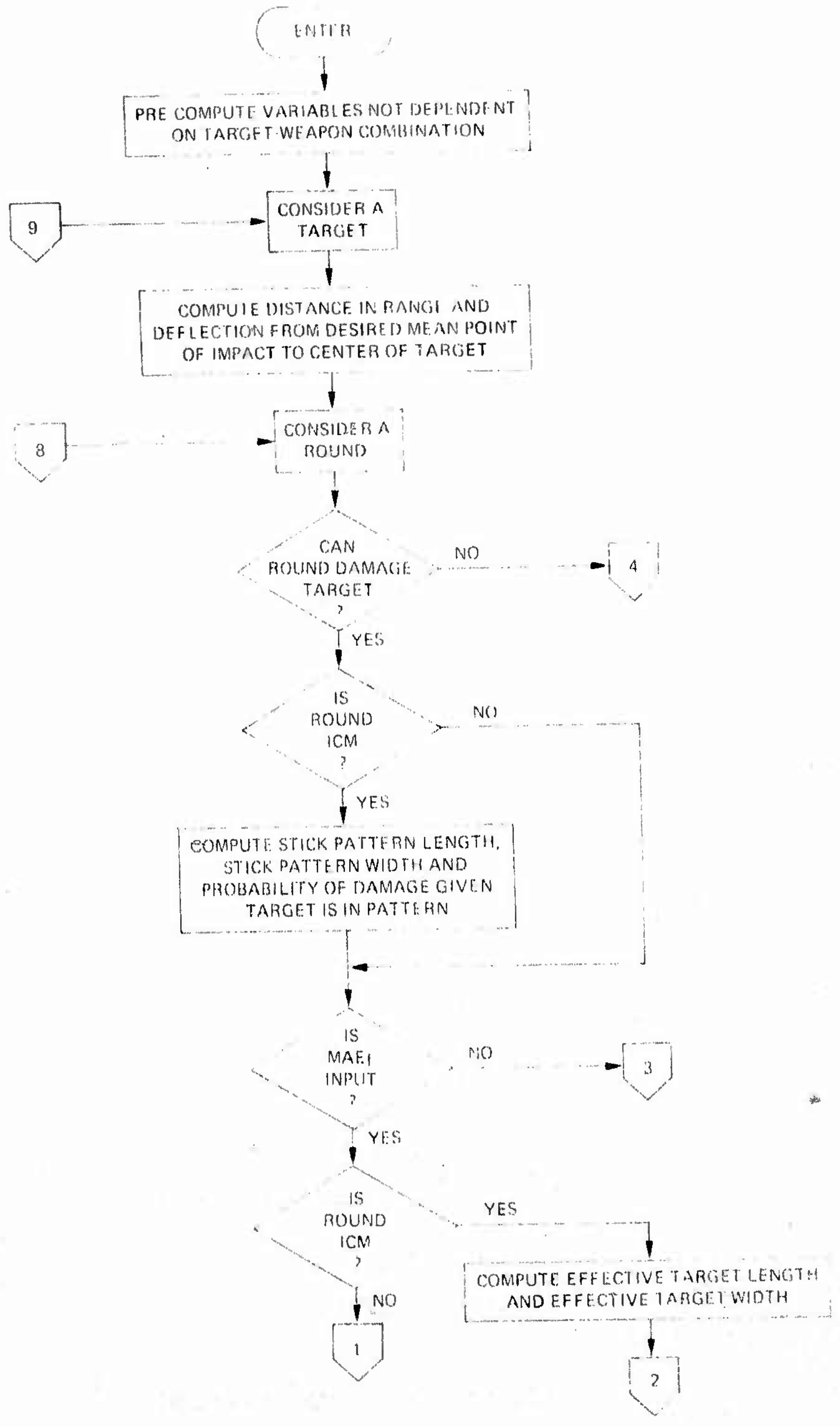

ENTER
PRE COMPUTE VARIABLES NOT DEPENDENT ON TARGET-WEAPON COMBINATION
9
CONSIDER A TARGET
COMPUTE DISTANCE IN RANGE AND DEFLECTION FROM DESIRED MEAN POINT OF IMPACT TO CENTER OF TARGET
8
CONSIDER A ROUND
CAN ROUND DAMAGE TARGET ?
NO
4
YES
IS ROUND ICM ?
NO
YES
COMPUTE STICK PATTERN LENGTH, STICK PATTERN WIDTH AND PROBABILITY OF DAMAGE GIVEN TARGET IS IN PATTERN
IS MAEI INPUT ?
NO
3
YES
IS ROUND ICM ?
YES
NO
1
COMPUTE EFFECTIVE TARGET LENGTH AND EFFECTIVE TARGET WIDTH
2

Figure 24. Flowchart, Subroutine NDFIRE

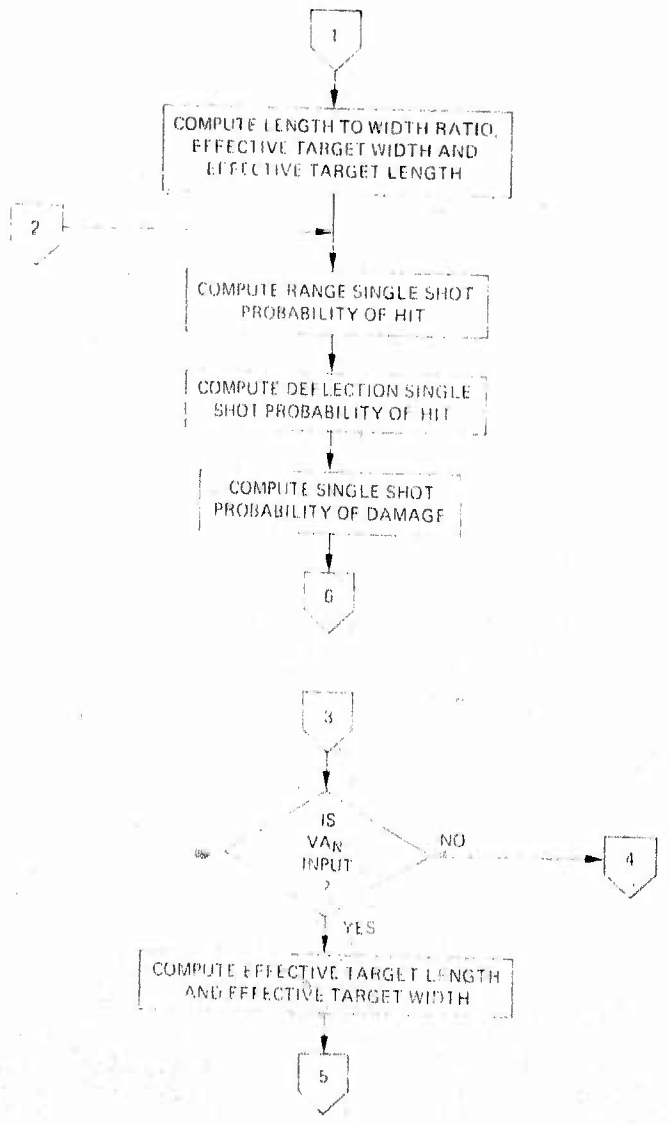

1
COMPUTE LENGTH TO WIDTH RATIO, EFFECTIVE TARGET WIDTH AND EFFECTIVE TARGET LENGTH
2
COMPUTE RANGE SINGLE SHOT PROBABILITY OF HIT
COMPUTE DEFLECTION SINGLE SHOT PROBABILITY OF HIT
COMPUTE SINGLE SHOT PROBABILITY OF DAMAGE
6
3
IS VA_N INPUT ?
NO
4
YES
COMPUTE EFFECTIVE TARGET LENGTH AND EFFECTIVE TARGET WIDTH
5

Figure 24. (Continued)

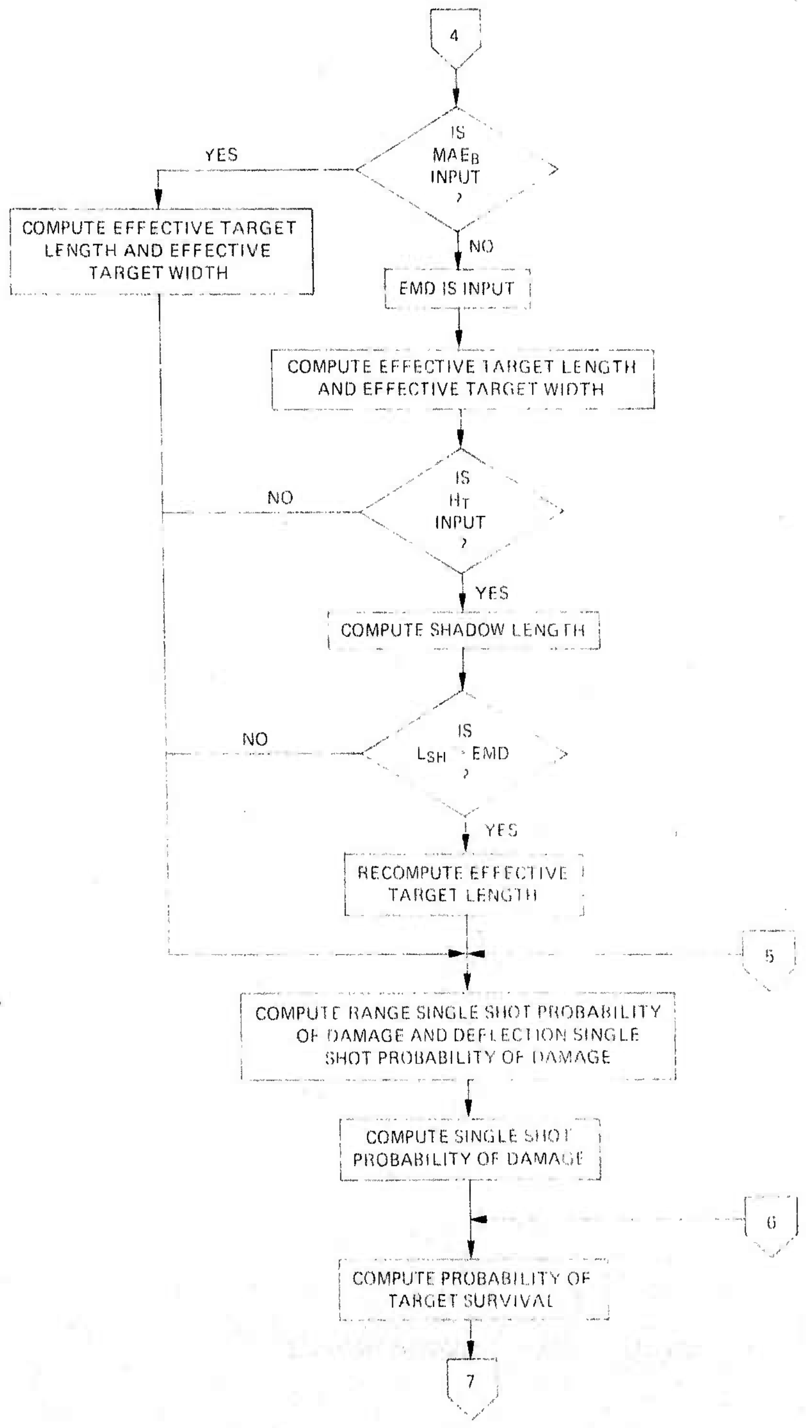

4
IS MAE_B INPUT ?
YES
NO
COMPUTE EFFECTIVE TARGET LENGTH AND EFFECTIVE TARGET WIDTH
EMD IS INPUT
COMPUTE EFFECTIVE TARGET LENGTH AND EFFECTIVE TARGET WIDTH
NO
IS H_T INPUT ?
YES
COMPUTE SHADOW LENGTH
NO
IS L_{SH} > EMD ?
YES
RECOMPUTE EFFECTIVE TARGET LENGTH
5
COMPUTE RANGE SINGLE SHOT PROBABILITY OF DAMAGE AND DEFLECTION SINGLE SHOT PROBABILITY OF DAMAGE
COMPUTE SINGLE SHOT PROBABILITY OF DAMAGE
6
COMPUTE PROBABILITY OF TARGET SURVIVAL
7

Figure 24. (Continued)

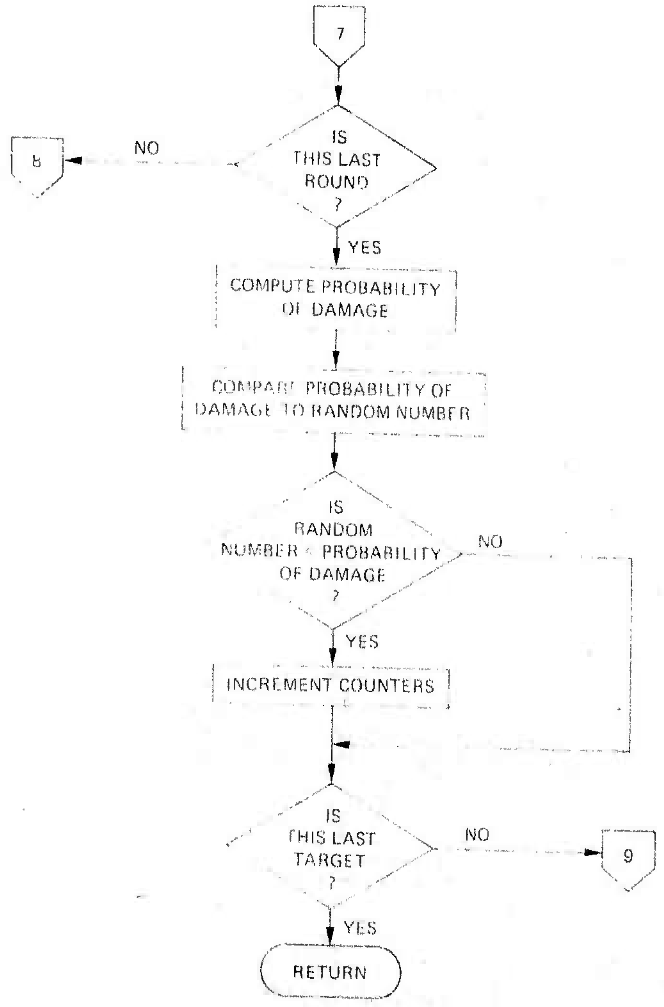

7
IS THIS LAST ROUND ?
NO
8
YES
COMPUTE PROBABILITY OF DAMAGE
COMPARE PROBABILITY OF DAMAGE TO RANDOM NUMBER
IS RANDOM NUMBER < PROBABILITY OF DAMAGE ?
NO
YES
INCREMENT COUNTERS
IS THIS LAST TARGET ?
NO
9
YES
RETURN

Figure 24. (Concluded)

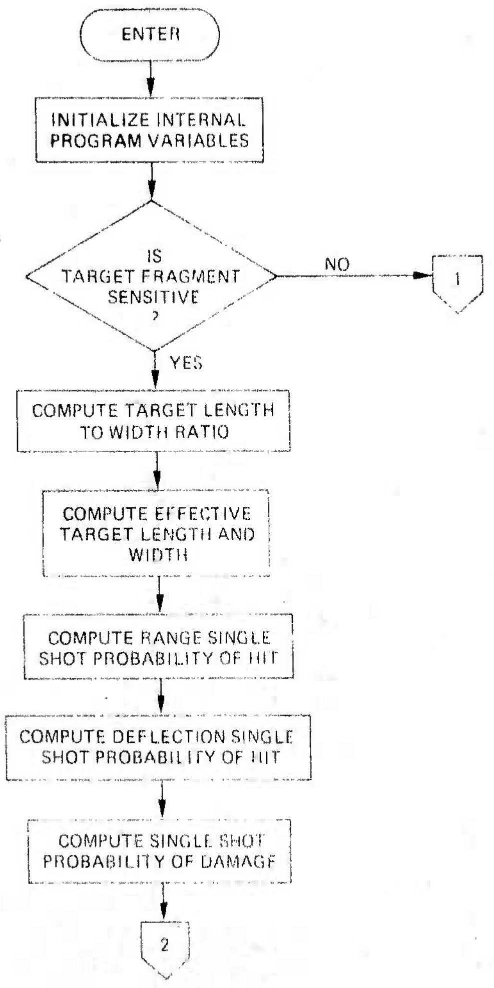

ENTER
INITIALIZE INTERNAL PROGRAM VARIABLES
IS TARGET FRAGMENT SENSITIVE ?
NO
1
YES
COMPUTE TARGET LENGTH TO WIDTH RATIO
COMPUTE EFFECTIVE TARGET LENGTH AND WIDTH
COMPUTE RANGE SINGLE SHOT PROBABILITY OF HIT
COMPUTE DEFLECTION SINGLE SHOT PROBABILITY OF HIT
COMPUTE SINGLE SHOT PROBABILITY OF DAMAGE
2

Figure 25. Flowchart, Subroutine DIRFIR

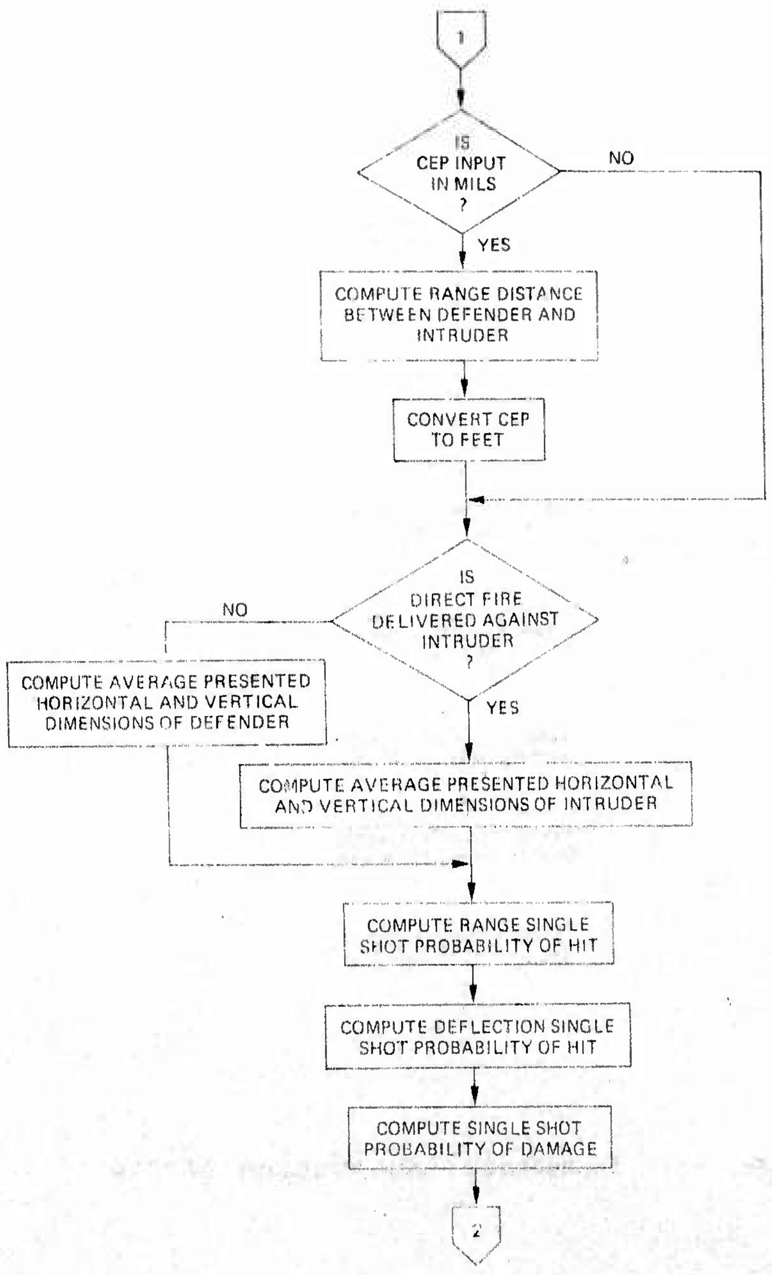

1
IS CEP INPUT IN MILS ?
NO
YES
COMPUTE RANGE DISTANCE BETWEEN DEFENDER AND INTRUDER
CONVERT CEP TO FEET
IS DIRECT FIRE DELIVERED AGAINST INTRUDER ?
NO
YES
COMPUTE AVERAGE PRESENTED HORIZONTAL AND VERTICAL DIMENSIONS OF DEFENDER
COMPUTE AVERAGE PRESENTED HORIZONTAL AND VERTICAL DIMENSIONS OF INTRUDER
COMPUTE RANGE SINGLE SHOT PROBABILITY OF HIT
COMPUTE DEFLECTION SINGLE SHOT PROBABILITY OF HIT
COMPUTE SINGLE SHOT PROBABILITY OF DAMAGE
2

Figure 25. (Continued)

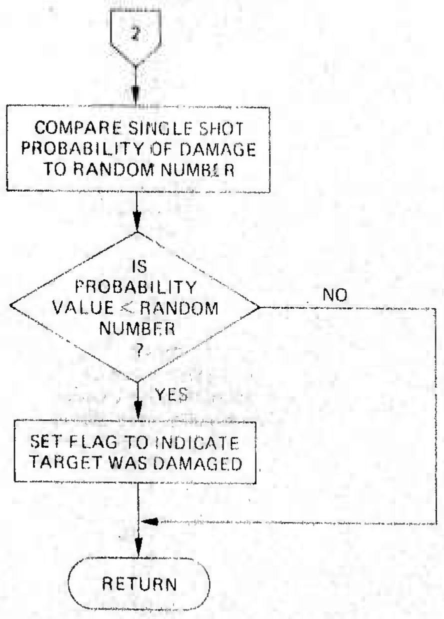

2
COMPARE SINGLE SHOT PROBABILITY OF DAMAGE TO RANDOM NUMBER
IS PROBABILITY VALUE < RANDOM NUMBER ?
NO
YES
SET FLAG TO INDICATE TARGET WAS DAMAGED
RETURN

Figure 25. (Concluded)

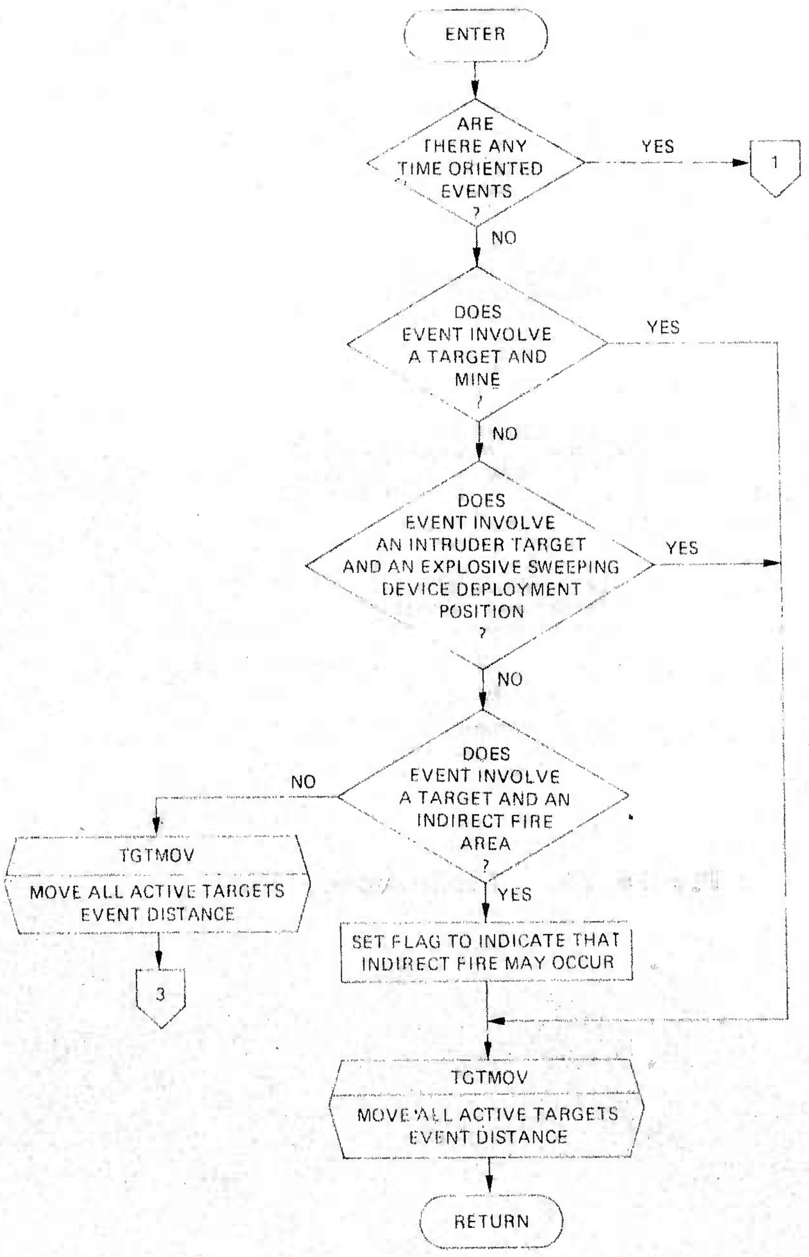

ENTER
ARE THERE ANY TIME ORIENTED EVENTS ?
YES
1
NO
DOES EVENT INVOLVE A TARGET AND MINE ?
YES
NO
DOES EVENT INVOLVE AN INTRUDER TARGET AND AN EXPLOSIVE SWEEPING DEVICE DEPLOYMENT POSITION ?
YES
NO
DOES EVENT INVOLVE A TARGET AND AN INDIRECT FIRE AREA ?
NO
YES
TGTMOV
MOVE ALL ACTIVE TARGETS EVENT DISTANCE
3
SET FLAG TO INDICATE THAT INDIRECT FIRE MAY OCCUR
TGTMOV
MOVE ALL ACTIVE TARGETS EVENT DISTANCE
RETURN

Figure 26. Flowchart, Subroutine CKEVTM

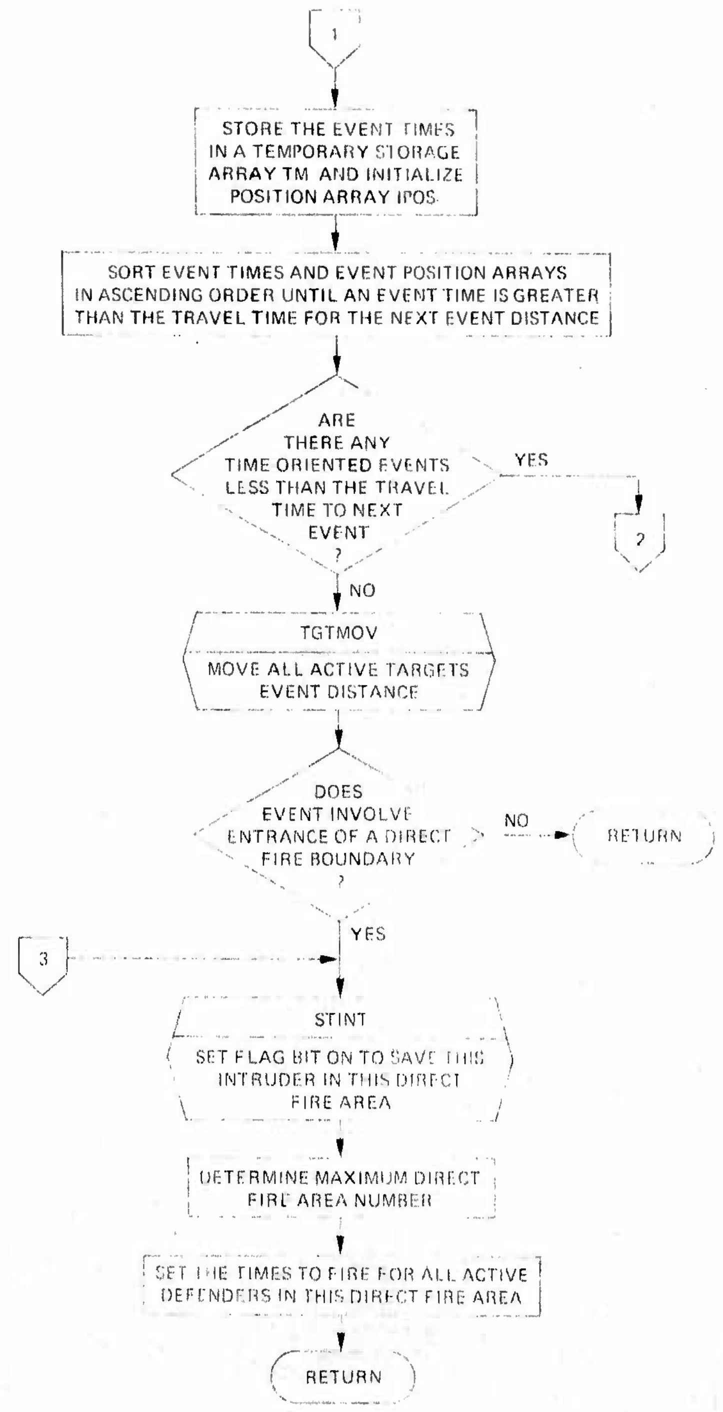

1
STORE THE EVENT TIMES IN A TEMPORARY STORAGE ARRAY TM AND INITIALIZE POSITION ARRAY IPOS.
SORT EVENT TIMES AND EVENT POSITION ARRAYS IN ASCENDING ORDER UNTIL AN EVENT TIME IS GREATER THAN THE TRAVEL TIME FOR THE NEXT EVENT DISTANCE
ARE THERE ANY TIME ORIENTED EVENTS LESS THAN THE TRAVEL TIME TO NEXT EVENT ?
YES
2
NO
TGTMOV
MOVE ALL ACTIVE TARGETS EVENT DISTANCE
DOES EVENT INVOLVE ENTRANCE OF A DIRECT FIRE BOUNDARY ?
NO
RETURN
YES
3
STINT
SET FLAG BIT ON TO SAVE THIS INTRUDER IN THIS DIRECT FIRE AREA
DETERMINE MAXIMUM DIRECT FIRE AREA NUMBER
SET THE TIMES TO FIRE FOR ALL ACTIVE DEFENDERS IN THIS DIRECT FIRE AREA
RETURN

Figure 26. (Continued)

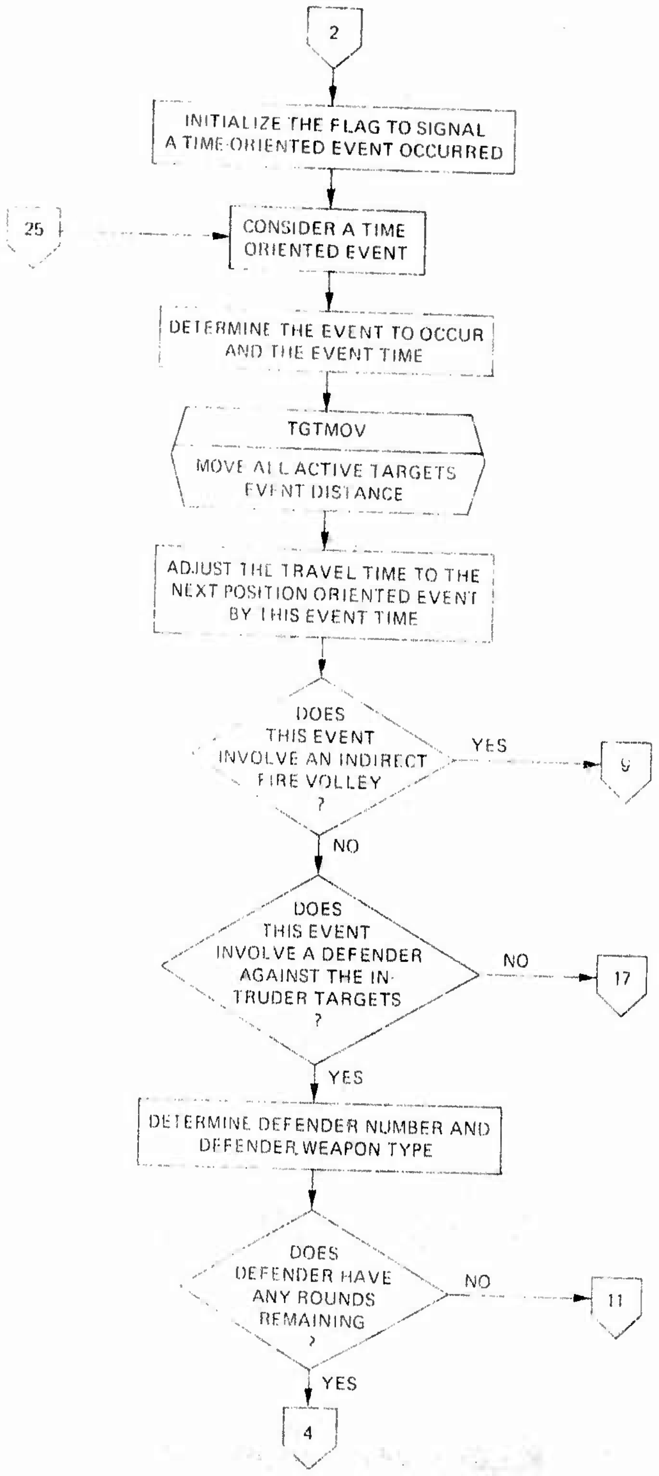
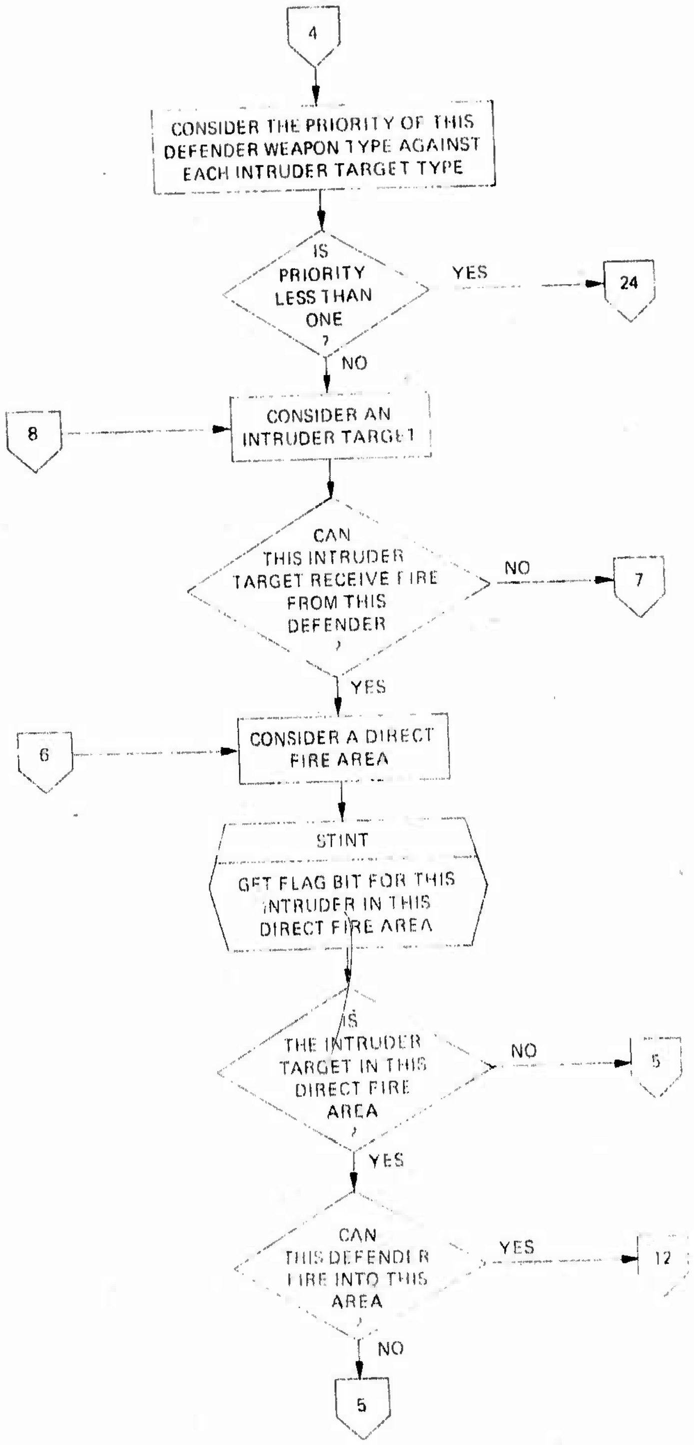

2
INITIALIZE THE FLAG TO SIGNAL A TIME-ORIENTED EVENT OCCURRED
25
CONSIDER A TIME ORIENTED EVENT
DETERMINE THE EVENT TO OCCUR AND THE EVENT TIME
TGTMOV
MOVE ALL ACTIVE TARGETS EVENT DISTANCE
ADJUST THE TRAVEL TIME TO THE NEXT POSITION ORIENTED EVENT BY THIS EVENT TIME
DOES THIS EVENT INVOLVE AN INDIRECT FIRE VOLLEY ?
YES
9
NO
DOES THIS EVENT INVOLVE A DEFENDER AGAINST THE IN-TRUDER TARGETS ?
NO
17
YES
DETERMINE DEFENDER NUMBER AND DEFENDER WEAPON TYPE
DOES DEFENDER HAVE ANY ROUNDS REMAINING ?
NO
11
YES
4

Figure 26. (Continued)



4
CONSIDER THE PRIORITY OF THIS DEFENDER WEAPON TYPE AGAINST EACH INTRUDER TARGET TYPE
IS PRIORITY LESS THAN ONE ?
YES
24
NO
8
CONSIDER AN INTRUDER TARGET
CAN THIS INTRUDER TARGET RECEIVE FIRE FROM THIS DEFENDER ?
NO
7
YES
6
CONSIDER A DIRECT FIRE AREA
STINT
GET FLAG BIT FOR THIS INTRUDER IN THIS DIRECT FIRE AREA
IS THE INTRUDER TARGET IN THIS DIRECT FIRE AREA ?
NO
5
YES
CAN THIS DEFENDER FIRE INTO THIS AREA ?
YES
12
NO
5

Figure 26. (Continued)

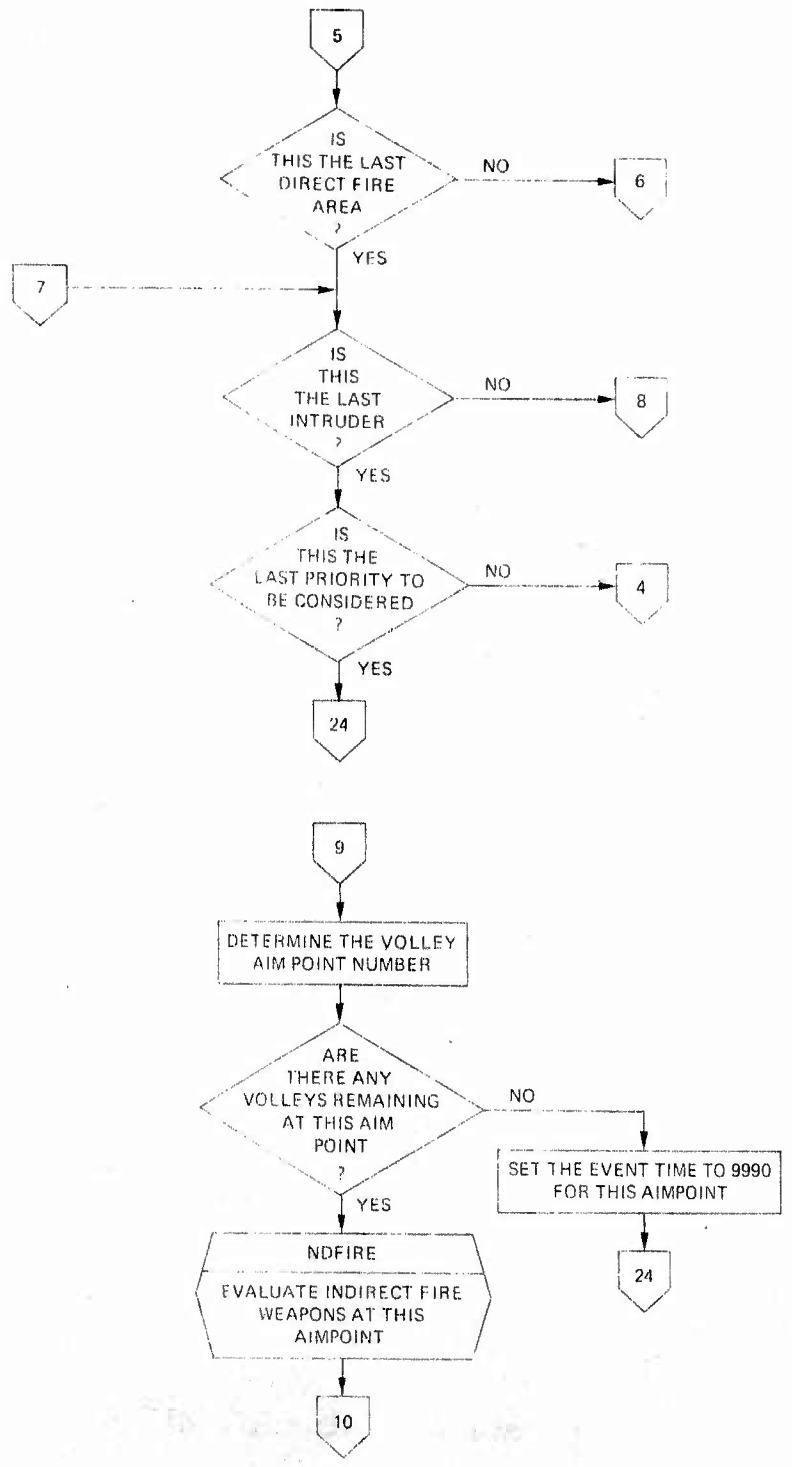

5
IS THIS THE LAST DIRECT FIRE AREA ?
NO
6
YES
7
IS THIS THE LAST INTRUDER ?
NO
8
YES
IS THIS THE LAST PRIORITY TO BE CONSIDERED ?
NO
4
YES
24
9
DETERMINE THE VOLLEY AIM POINT NUMBER
ARE THERE ANY VOLLEYS REMAINING AT THIS AIM POINT ?
NO
SET THE EVENT TIME TO 9990 FOR THIS AIMPOINT
24
YES
NDFIRE
EVALUATE INDIRECT FIRE WEAPONS AT THIS AIMPOINT
10

Figure 26. (Continued)

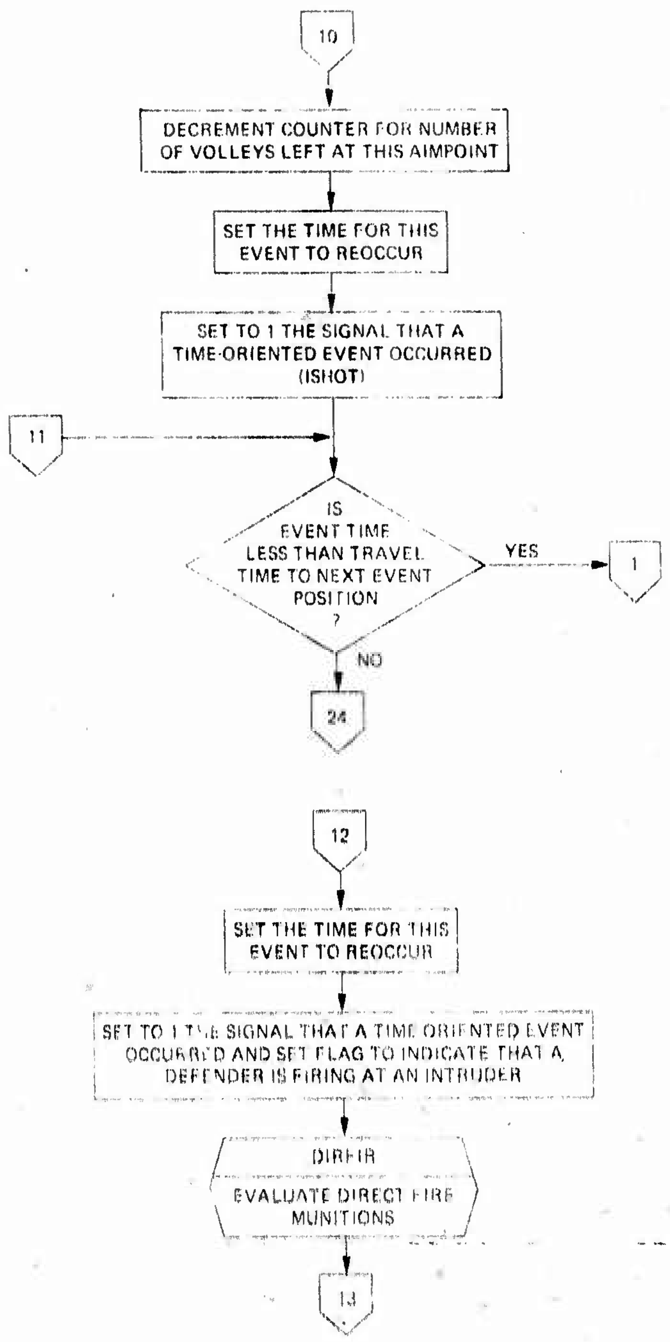

10
DECREMENT COUNTER FOR NUMBER OF VOLLEYS LEFT AT THIS AIMPOINT
SET THE TIME FOR THIS EVENT TO REOCCUR
SET TO 1 THE SIGNAL THAT A TIME-ORIENTED EVENT OCCURRED (ISHOT)
11
IS EVENT TIME LESS THAN TRAVEL TIME TO NEXT EVENT POSITION ?
YES
1
NO
24
12
SET THE TIME FOR THIS EVENT TO REOCCUR
SET TO 1 THE SIGNAL THAT A TIME ORIENTED EVENT OCCURRED AND SET FLAG TO INDICATE THAT A DEFENDER IS FIRING AT AN INTRUDER
DIRFIR
EVALUATE DIRECT FIRE MUNITIONS
13

Figure 26. (Continued)

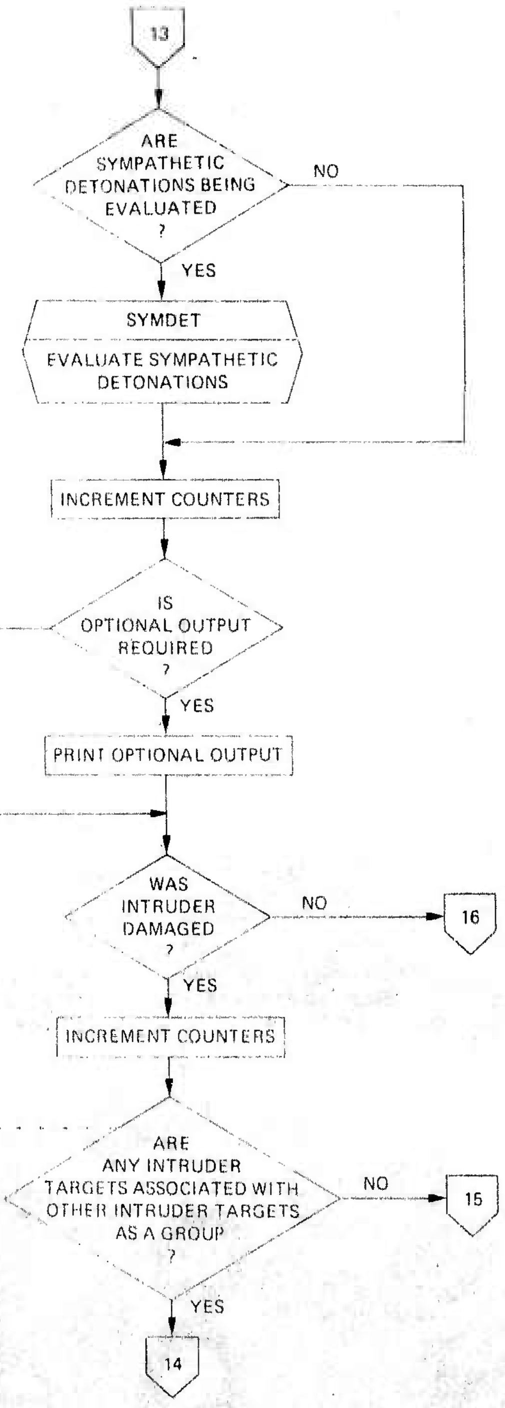

13
ARE SYMPATHETIC DETONATIONS BEING EVALUATED ?
NO
YES
SYMDET
EVALUATE SYMPATHETIC DETONATIONS
INCREMENT COUNTERS
IS OPTIONAL OUTPUT REQUIRED ?
NO
YES
PRINT OPTIONAL OUTPUT
WAS INTRUDER DAMAGED ?
NO
16
YES
INCREMENT COUNTERS
ARE ANY INTRUDER TARGETS ASSOCIATED WITH OTHER INTRUDER TARGETS AS A GROUP ?
NO
15
YES
14

Figure 26. (Continued)

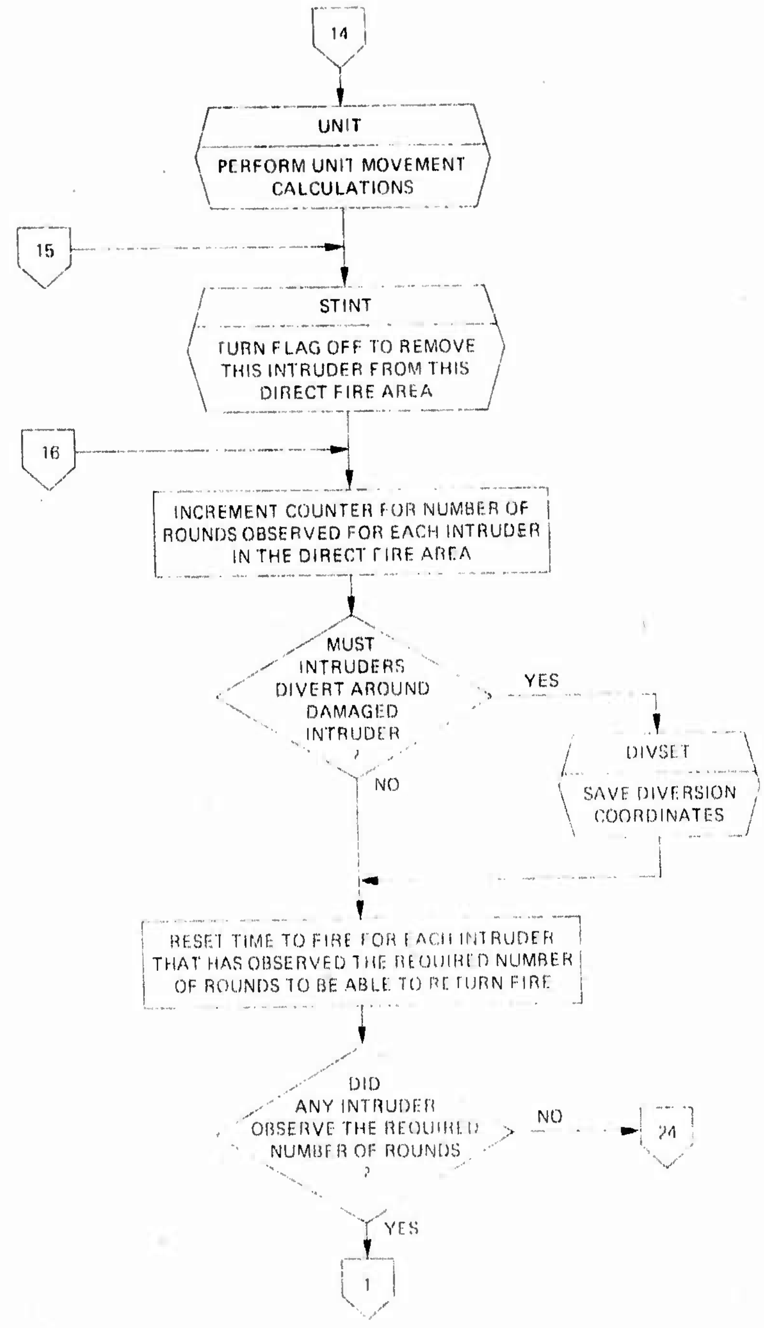

14
UNIT
PERFORM UNIT MOVEMENT CALCULATIONS
15
STINT
TURN FLAG OFF TO REMOVE THIS INTRUDER FROM THIS DIRECT FIRE AREA
16
INCREMENT COUNTER FOR NUMBER OF ROUNDS OBSERVED FOR EACH INTRUDER IN THE DIRECT FIRE AREA
MUST INTRUDERS DIVERT AROUND DAMAGED INTRUDER ?
YES
NO
DIVSET
SAVE DIVERSION COORDINATES
RESET TIME TO FIRE FOR EACH INTRUDER THAT HAS OBSERVED THE REQUIRED NUMBER OF ROUNDS TO BE ABLE TO RETURN FIRE
DID ANY INTRUDER OBSERVE THE REQUIRED NUMBER OF ROUNDS ?
NO
24
YES
1

Figure 26. (Continued)

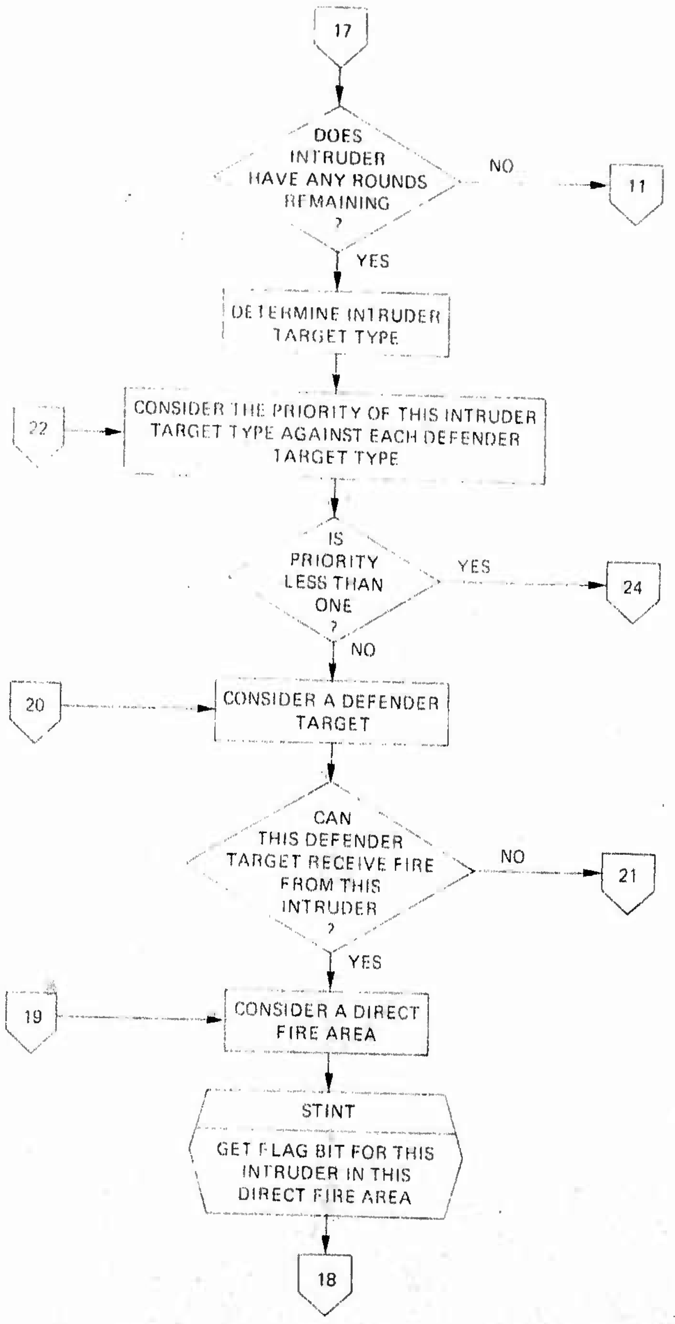

17
DOES INTRUDER HAVE ANY ROUNDS REMAINING ?
NO
11
YES
DETERMINE INTRUDER TARGET TYPE
22
CONSIDER THE PRIORITY OF THIS INTRUDER TARGET TYPE AGAINST EACH DEFENDER TARGET TYPE
IS PRIORITY LESS THAN ONE ?
YES
24
NO
20
CONSIDER A DEFENDER TARGET
CAN THIS DEFENDER TARGET RECEIVE FIRE FROM THIS INTRUDER ?
NO
21
YES
19
CONSIDER A DIRECT FIRE AREA
STINT
GET FLAG BIT FOR THIS INTRUDER IN THIS DIRECT FIRE AREA
18

Figure 26. (Continued)

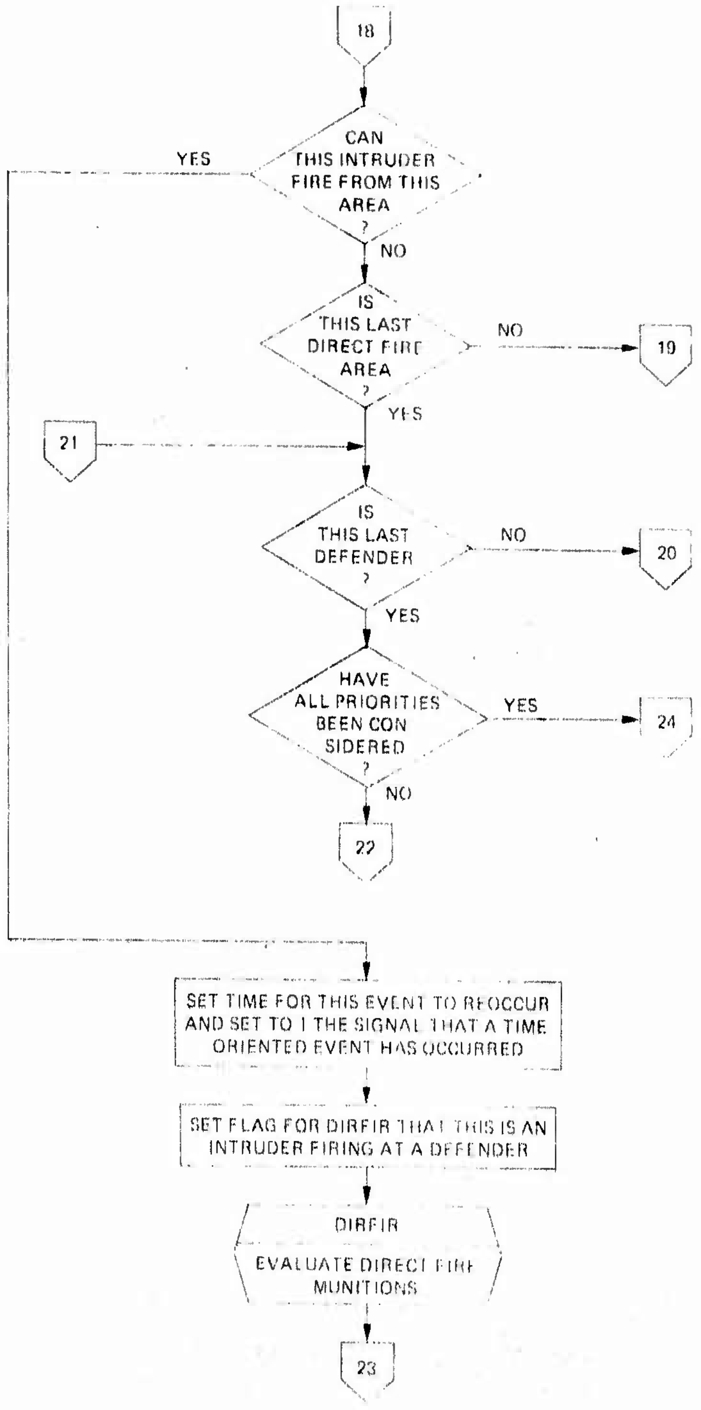

18
CAN THIS INTRUDER FIRE FROM THIS AREA ?
YES
NO
IS THIS LAST DIRECT FIRE AREA ?
NO
19
YES
21
IS THIS LAST DEFENDER ?
NO
20
YES
HAVE ALL PRIORITIES BEEN CON SIDERED ?
YES
24
NO
22
SET TIME FOR THIS EVENT TO REOCCUR AND SET TO 1 THE SIGNAL THAT A TIME ORIENTED EVENT HAS OCCURRED
SET FLAG FOR DIRFIR THAT THIS IS AN INTRUDER FIRING AT A DEFENDER
DIRFIR
EVALUATE DIRECT FIRE MUNITIONS
23

Figure 26. (Continued)

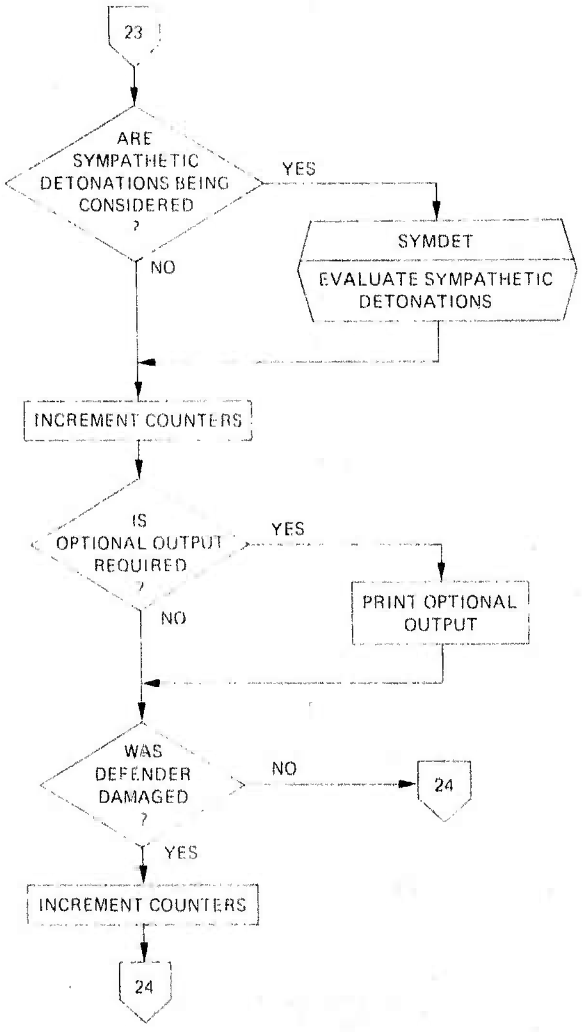

23
ARE SYMPATHETIC DETONATIONS BEING CONSIDERED ?
YES
NO
SYMDET
EVALUATE SYMPATHETIC DETONATIONS
INCREMENT COUNTERS
IS OPTIONAL OUTPUT REQUIRED ?
YES
NO
PRINT OPTIONAL OUTPUT
WAS DEFENDER DAMAGED ?
NO
24
YES
INCREMENT COUNTERS
24

Figure 26. (Continued)

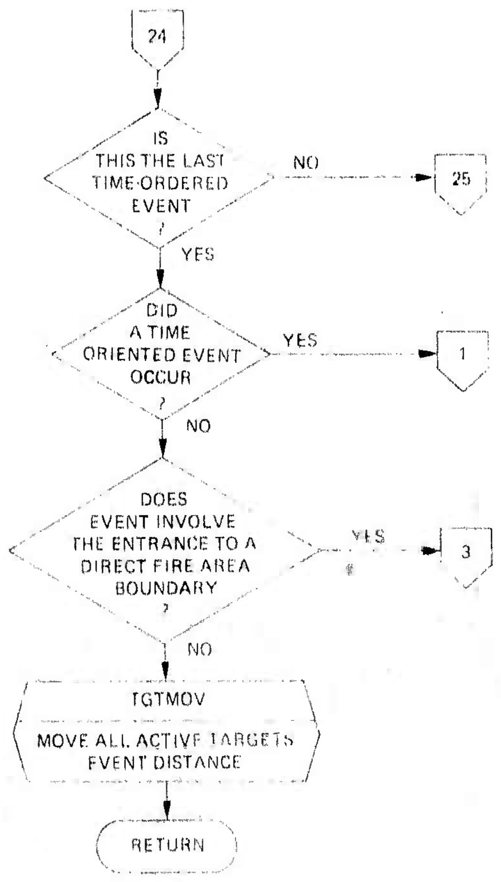

24
IS THIS THE LAST TIME-ORDERED EVENT ?
NO
25
YES
DID A TIME ORIENTED EVENT OCCUR ?
YES
1
NO
DOES EVENT INVOLVE THE ENTRANCE TO A DIRECT FIRE AREA BOUNDARY ?
YES
3
NO
TGTMOV
MOVE ALL ACTIVE TARGETS EVENT DISTANCE
RETURN

Figure 26. (Concluded)

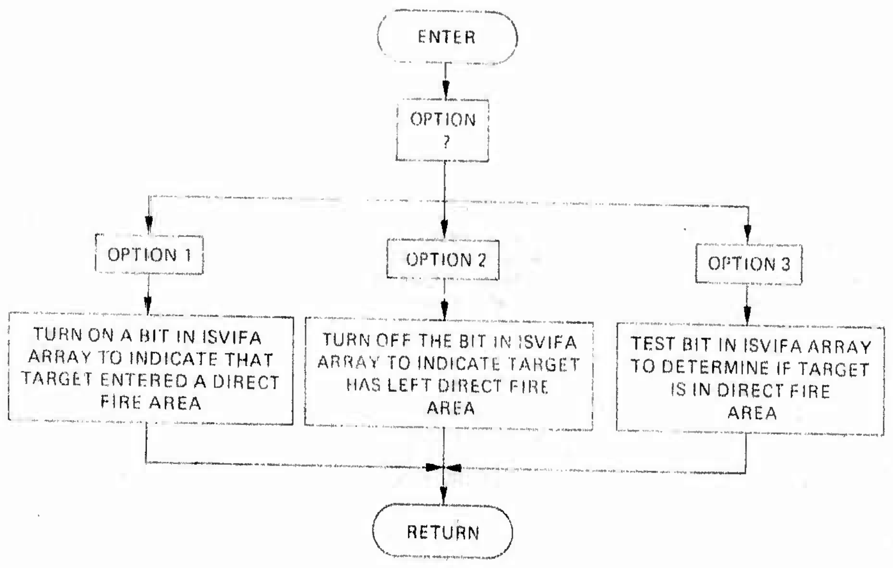

ENTER
OPTION ?
OPTION 1
OPTION 2
OPTION 3
TURN ON A BIT IN ISVIFA ARRAY TO INDICATE THAT TARGET ENTERED A DIRECT FIRE AREA
TURN OFF THE BIT IN ISVIFA ARRAY TO INDICATE TARGET HAS LEFT DIRECT FIRE AREA
TEST BIT IN ISVIFA ARRAY TO DETERMINE IF TARGET IS IN DIRECT FIRE AREA
RETURN

Figure 27. Flowchart, Subroutine STINT

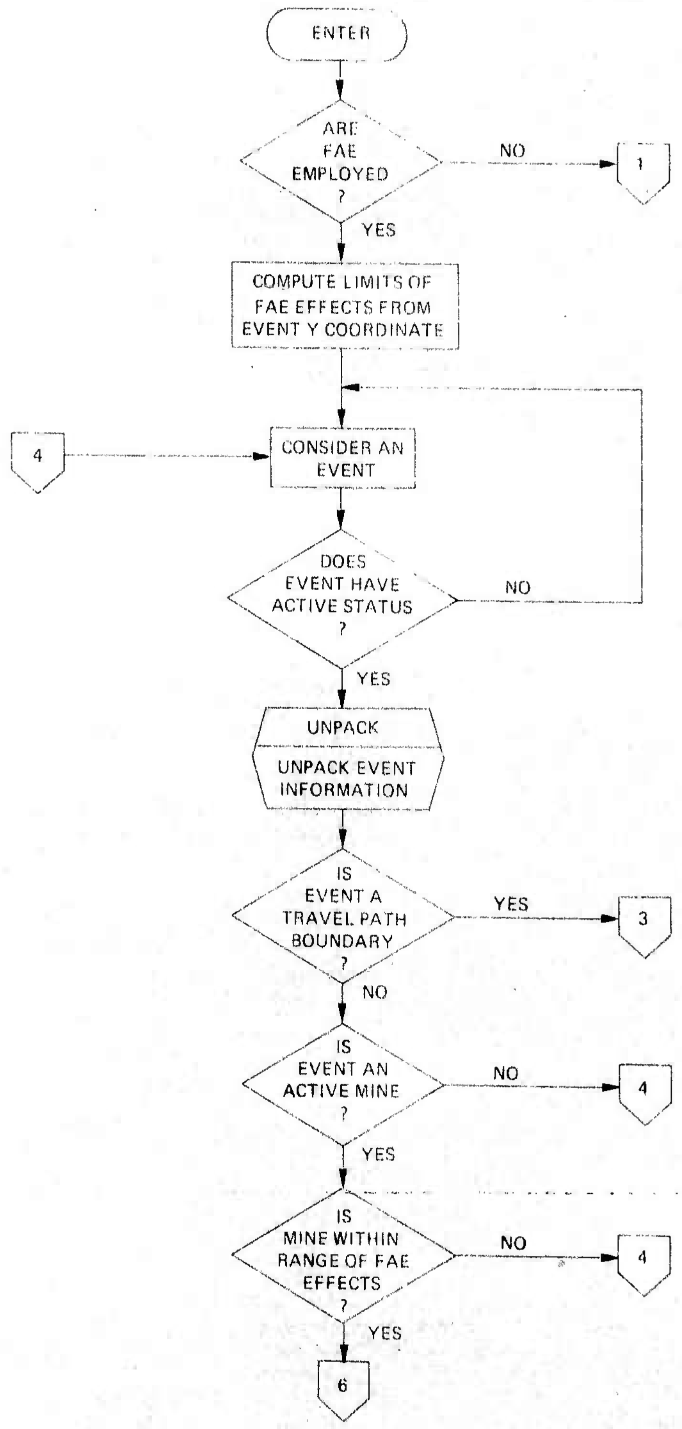

ENTER
ARE FAE EMPLOYED ?
NO
1
YES
COMPUTE LIMITS OF FAE EFFECTS FROM EVENT Y COORDINATE
4
CONSIDER AN EVENT
DOES EVENT HAVE ACTIVE STATUS ?
NO
YES
UNPACK
UNPACK EVENT INFORMATION
IS EVENT A TRAVEL PATH BOUNDARY ?
YES
3
NO
IS EVENT AN ACTIVE MINE ?
NO
4
YES
IS MINE WITHIN RANGE OF FAE EFFECTS ?
NO
4
YES
6

Figure 28. Flowchart, Subroutine EXPSWP

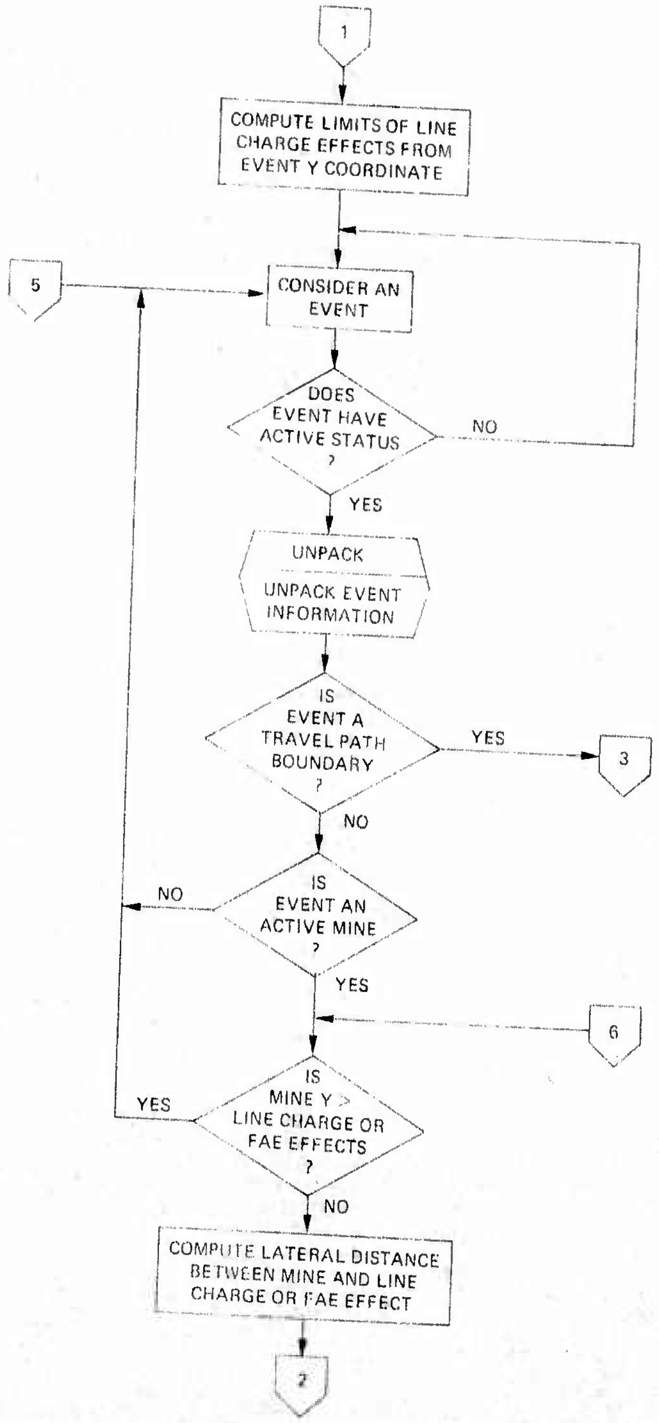

1
COMPUTE LIMITS OF LINE CHARGE EFFECTS FROM EVENT Y COORDINATE
5
CONSIDER AN EVENT
DOES EVENT HAVE ACTIVE STATUS ?
NO
YES
UNPACK
UNPACK EVENT INFORMATION
IS EVENT A TRAVEL PATH BOUNDARY ?
YES
3
NO
IS EVENT AN ACTIVE MINE ?
NO
YES
6
IS MINE Y > LINE CHARGE OR FAE EFFECTS ?
YES
NO
COMPUTE LATERAL DISTANCE BETWEEN MINE AND LINE CHARGE OR FAE EFFECT
2

Figure 28. (Continued)

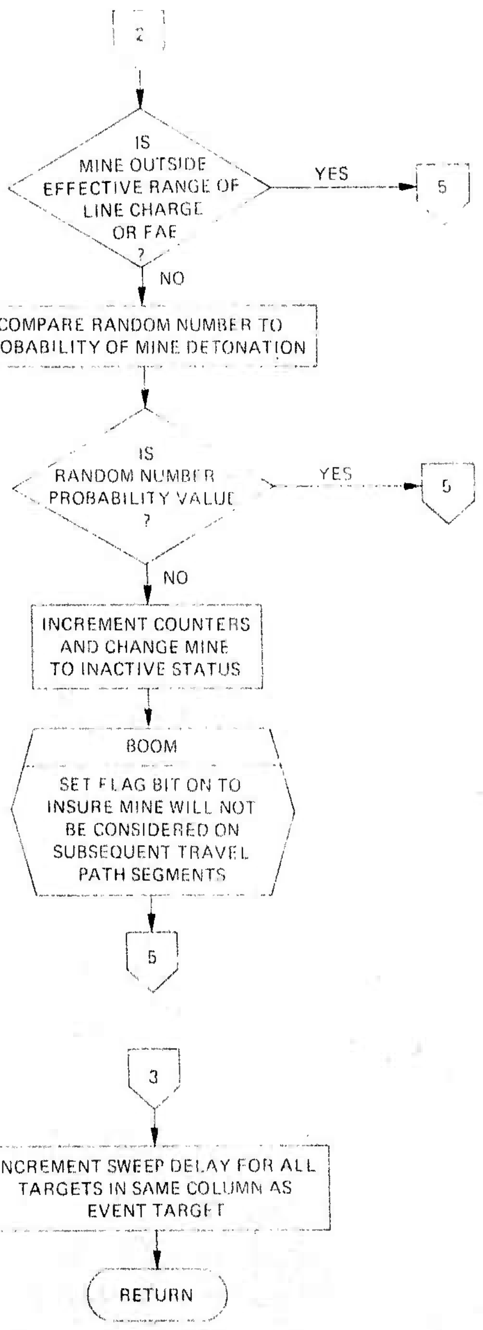

2
IS MINE OUTSIDE EFFECTIVE RANGE OF LINE CHARGE OR FAE ?
YES
5
NO
COMPARE RANDOM NUMBER TO PROBABILITY OF MINE DETONATION
IS RANDOM NUMBER PROBABILITY VALUE ?
YES
5
NO
INCREMENT COUNTERS AND CHANGE MINE TO INACTIVE STATUS
BOOM
SET FLAG BIT ON TO INSURE MINE WILL NOT BE CONSIDERED ON SUBSEQUENT TRAVEL PATH SEGMENTS
5
3
INCREMENT SWEEP DELAY FOR ALL TARGETS IN SAME COLUMN AS EVENT TARGET
RETURN

Figure 28. (Concluded)

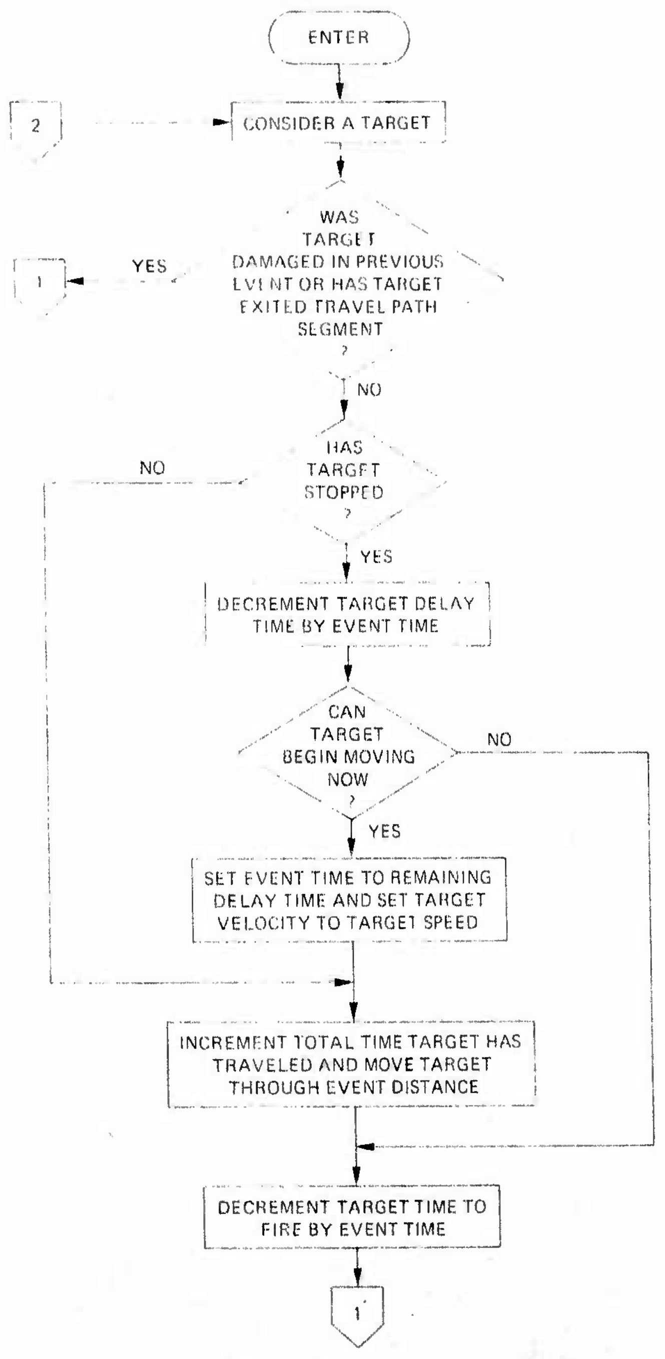

ENTER
2
CONSIDER A TARGET
WAS TARGET DAMAGED IN PREVIOUS EVENT OR HAS TARGET EXITED TRAVEL PATH SEGMENT ?
YES
1
NO
HAS TARGET STOPPED ?
NO
YES
DECREMENT TARGET DELAY TIME BY EVENT TIME
CAN TARGET BEGIN MOVING NOW ?
NO
YES
SET EVENT TIME TO REMAINING DELAY TIME AND SET TARGET VELOCITY TO TARGET SPEED
INCREMENT TOTAL TIME TARGET HAS TRAVELED AND MOVE TARGET THROUGH EVENT DISTANCE
DECREMENT TARGET TIME TO FIRE BY EVENT TIME
1

Figure 29. Flowchart, Subroutine TGTMOV

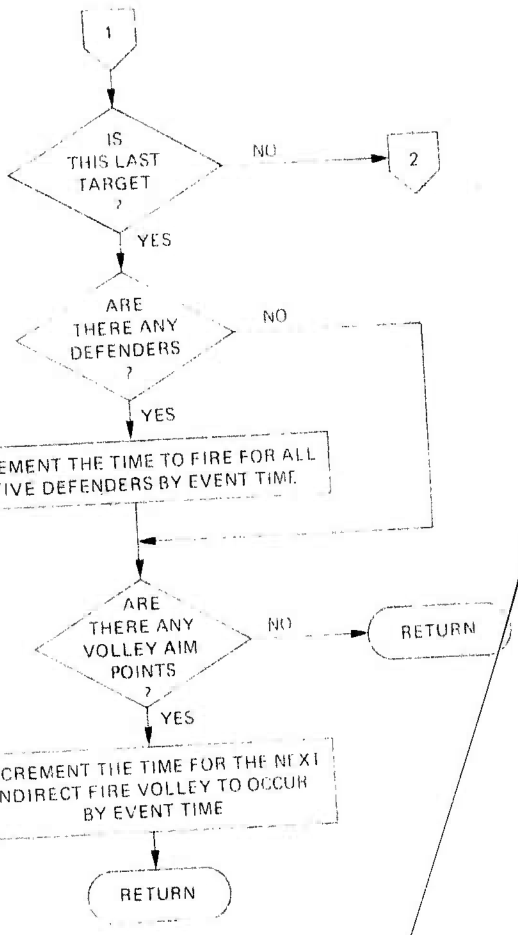

1
IS THIS LAST TARGET ?
NO
2
YES
ARE THERE ANY DEFENDERS ?
NO
YES
DECREMENT THE TIME TO FIRE FOR ALL ACTIVE DEFENDERS BY EVENT TIME
ARE THERE ANY VOLLEY AIM POINTS ?
NO
RETURN
YES
DECREMENT THE TIME FOR THE NEXT INDIRECT FIRE VOLLEY TO OCCUR BY EVENT TIME
RETURN

Figure 29. (Concluded)

SECTION IV

SOURCE LISTING

Figure 30 presents a complete source listing of SEMAC which can be used to check the validity of the program.

```
*DECK SEMAC
      PROGRAM SEMAC(OUTPUT=129,INPUT,TAPE5=INPUT,TAPE6=OUTPUT,
     *TAPE1=513,TAPE2=513,TAPE4=129,TAPE7=513)
C
C         MINEFIELD SIMULATION MODEL WITH COVERING FIRE - SEMAC
C
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUDPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INOFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LDFOPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NDVT,NGTAW(100),NGTAWT,NGTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),PDLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PRDTNO(5,7),PRKLO(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRO(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C****
      KREAD = 0
 5    CALL READIN (KREAD)
 20   CALL SETUP
   25 CALL ROAD
      CALL SORT(IOB,NOB)
      IF(LEFTIN.EQ.0) GO TO 160
 30   CALL LOOPS
      TGTVSV=TGTVEL(ISAVE)
      IPO=1H
      ISYP=0
      KT = KTSAV(ISAVE)
      IWORD = IOB(KT)
      CALL UNPACK
      OBYPRT=OBY
      CALL CKEVTM
      IF(TGTYNW(ISAVE).GT.99990.) GO TO 110
      IF(TGTVSV.GT.0.01)GO TO 50
      KTSAV(ISVLST)=KTSAV(ISVLST)-1
      GO TO 30
   50 GO TO (72,72,72,72,72,72,72,75,72,72,72,72,72,72,72,
     *80,110,100,77) NOBTP2
   72 CALL TGTMIN
      IF(NGTAWT.GE.1.AND.ISYP.EQ.2) CALL UNIT
      GO TO 110
   75 CALL EVENTC
      GOTO 110
   77 IF(TGTXOL(ISAVE).NE.OBX.OR.NTGTYP(ISAVE).NE.LCFTT)GO TO 150
      CALL EXPSWP
      GO TO 110
   80 IF(IT.NE.NCTAW(ISAVE))GO TO 150
      IVAP=IMINE
      CALL NOFIRE
      CALL BOOM(IDET,1)
      INDFA=1
      IOB(KT)=-1
```

Figure 30. SEMAC Source Listing

```
      NVLIDF(IVAP)=NVLIDF(IVAP)-1
      TMTOFR(IVAP+120)=TOBIFV(IVAP)
      GO TO 110
  100 CALL STINT(ISVIFA,ISAVE,IT,IBIT,KDFTTN,2)
      IF(KDFTTN(ISAVE).GT.0) GO TO 102
      NRFIRD(ISAVE)=0
      TMTOFR(ISAVE)=9990.
  102 JAA=0
      DO 105 J=1,30
      IF(ISVIFA(J))103,105
  103 JAA=J
  105 CONTINUE
      IF(JAA.LT.1) GO TO 109
      NDFA=MOD(JAA,15)
      IF(NDFA.LT.1)NDFA=15
      GO TO 110
  109 NDFA=0
  110 IF(NOBEVT.GT.0.AND.IRUNS.EQ.IPRINT)
     *  CALL PRINTO
      NOBEVT=IABS(NOBEVT)
      IF(INDFA)130,150
  130 JAA=0
      DO 140 I=1,NVAP
      IF(NVLIDF(I))140,140,135
  135 JAA=I
  140 CONTINUE
      INDFA=JAA
  150 IF(NSPLFT.GT.0.OR.KNRS.NE.NRS) GO TO 155
      NSPLFT=99999
      DO 152 I=1,NTGO
      IF(TGTYNW(I).LT.99970.) TGTVEL(I)=TGTOVL
  152 CONTINUE
      TOTSPD=TGTOVL
  155 IF(LEFTIN.GT.0) GO TO 30
  160 IF(KNRS.NE.NRS) GO TO 25
      CALL PRINTR
      IF (IRUNS .LT. NOIT) GO TO 20
      KREAD = 1
      GO TO 5
      END
```

Figure 30. (Continued)

```
      SUBROUTINE READIN (KREAD)
      COMMON ACEP(5,2),ADEP(20),AE(5,5,4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUDPRB(7),O3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LDFDPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NDVT,NOTAW(100),NOTAWT,NOTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),PDLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PROTNO(5,7),PRKLO(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,50),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRO(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C*****
      DIMENSION ORX(4),ORY(4),XYMS(4),RNGSV(3)
      DIMENSION HOL(8),SECOFF(7),PROBTP(8),RANGTP(8)
      DATA ITEST/5H  999/
      REWIND 2
      WRITE(6,1480)
      IF(KREAD.EQ.1) GO TO 24
      CALL REPRNT
 8010 DO 7 I=1,840
      PROBIL(I) = 0.0
      RANGPR(I) = 0.0
 7    CONTINUE
      ND=0
      OBX=OBY=0.
      DO 6 I=1,10
    6 NVFAEA(I)=0
      DO 8 J=1,15
      DO 8 I=1,20
    8 NDEFEA(J,I)=0
      LCFOPT=0
      MADIV=0
      DO 9 I=1,5
      NRAI(I)=NRAD(I)=0
      TARRAD(I)=TARL(I)=TARW(I)=TARHT(I)=0.
      REP(I)=REP(I*2)=0.
      DEP(I)=DEP(I*2)=0.
      NSUB(I)=1
      DO 9 J=1,7
      SYMDDF(I,J)=0.
    9 SYMDIF(I,J)=0.
      DO 10 I=1,7
      TMSWP(I)=SECON(I)=SECOFF(I)=XCYCLE(I)=0.
      DO 10 J=1,7
   10 SYMDIS(I,J)=0.
      IEND = 0
   24 IEND = IEND + 1
      JMARKI=1
      IRUNS=0
      DO 23 I=1,100
   23 DELATM(I)=0
      DO 25 I=1,7
   25 INTIME(I)=0
      READ(4,9000) HOL
      DECODE(80,9000,HOL) INPUT
```

Figure 30. (Continued)

```
      IF(INPUT.EQ.ITEST) CALL EXIT
      DO 38 J=1,52
      DO 38 I=1,5
      STATAL(I,J)=0.
38    CONTINUE
   50 READ(4,9000)HOL
 9000 FORMAT(8A10)
      DECODE(5,9001,HOL) INPUT
 9001 FORMAT(I5)
      IF(INPUT.EQ.99) GO TO 7000
      IF(INPUT.GT.1000) GO TO 6900
      GO TO(100,200,300,400,500,600,700,800,900,1000,1100,1200,1300,1400
     *,1500,1600,1700,1800,1900,2000,2100,2200,2300,2400) INPUT
  100 DECODE(80,9002,HOL)NAP,NTGO,NTGTP,NOIT,NOSTAT,IPRINT,SEED,
     *NMT,MODE,NVAP,NOFAA,NDFWD,NRBA
 9002 FORMAT(5X,6I5,F10.2,6I5)
      IF(SEED.LE.0.) SEED=RANF(DUMMY)
      CALL RANSET(SEED)
      GO TO 50
  200 DECODE(80,9003,HOL)ILCFOPT,YLENGTH,XWIDTH,THETA,D3DEL,
     *(ISYMP(I),I=1,3),ISBL,ITEROP,IDISOP
 9003 FORMAT(5X,I5,2F10.2,2F5.2,4I5,I2,I3)
      GO TO 50
  300 DECODE(80,9004,HOL)NTN,NTGTYP(NTN),NCTAW(NTN),NGTAW(NTN),
     *TGTXOL(NTN),TGTYOL(NTN),N1,N2,N3,N4,T1,T2
      IF(N1.LT.1)GO TO 50
      NTGTYP(N1)=N2
      NCTAW(N1)=N3
      NGTAW(N1)=N4
      TGTXOL(N1)=T1
      TGTYOL(N1)=T2
 9004 FORMAT(2(5X,I5,I1,I4,I5,2F10.2))
      GO TO 50
  400 DECODE(80,9005,HOL)ITYP,TARL(ITYP),TARW(ITYP),TARRAD(ITYP),
     *TARHT(ITYP),TMBRI(ITYP),NRAI(ITYP),(LDFOPR(ITYP,I),I=1,5),
     *NTTICS(ITYP),NTTTMD(ITYP),NTTTRP(ITYP)
      IF(NTTTMD(ITYP).GT.0)MADIV=1
 9005 FORMAT(5X,I5,4F10.2,F5.2,I5,5I1,3I5)
      GO TO 50
  500 DECODE(80,9091,HOL)IVAP,IROAD,XOVP(IVAP),YOVP(IVAP),AYYVP(IVAP),
     *NVFAEA(IVAP),NWEPV(IVAP),IWTVAP(IVAP),NTLCIF(IVAP),TDBIFV(IVAP)
 9091 FORMAT(10X,2I5,3F10.2,4I5,F10.2)
      IVPO=IFIX(XOVP(IVAP)*100.)
      XOVP(IVAP)=FLOAT(IVPO*100+IROAD*ISIGN(1,IVPO))
      GO TO 50
  600 DECODE(80,9090,HOL)IVAP,IWEPV,DMPIIX(IVAP,IWEPV),
     *DMPIIY(IVAP,IWEPV)
 9090 FORMAT(10X,2I5,2F10.2)
      GO TO 50
  700 DECODE(80,9015,HOL)IVAP,IWT,ANGIMP(IVAP),REP(IVAP),DEP(IVAP),
     *NSUB(IWT),RELSUB(IWT),PATRAD(IWT),RELRND(IWT)
 9015 FORMAT(5X,2I5,F5.2,2F10.2,I5,3F10.2)
      GO TO 50
  800 DECODE(80,9089,HOL)NRS,TGTOVL,TGTVL2
 9089 FORMAT(10X,I5,2F10.2)
      TGTOVL=TGTOVL*88.
      TGTVL2=TGTVL2*88.
      N=NRS+1
      READ(4,9007)(XROAD(I),YROAD(I),I=1,N)
 9007 FORMAT(8F10.2)
      GO TO 50
  900 DECODE(80,9013,HOL)IAP,MTFA(IAP),NSTICK(IAP),AIMPTX(IAP),
     *AIMPTY(IAP),YSWATH(IAP),XSWATH(IAP)
 9013 FORMAT(5X,3I5,4F10.2)
      GO TO 50
 1000 DECODE(80,9012,HOL)IAP,SIGAR(IAP),SIGAD(IAP),SIGBR(IAP),SIGBD(IAP)
 9012 FORMAT(5X,I5,4F10.2)
      GO TO 50
 1100 DECODE(80,9009,HOL)MT,JSELDS(MT),TMSWP(MT),DUDPRB(MT),PPEAF(MT)
 9009 FORMAT(10X,2I5,3F10.2)
      IF(JSELDS(MT).GT.0) GO TO 50
      DO 902 M=1,NAP
```

Figure 30. (Continued)

```
      IF(MTFA(M).EQ.MT) GO TO 903
  902 CONTINUE
  903 J=0
  905 READ(4,9007)(ORX(I),ORY(I),I=1,4)
      DO 910 I=1,4
      WRITE(2) ORX(I),ORY(I),MT
      IF(J+I.EQ.NSTICK(M)) GO TO 50
  910 CONTINUE
      J=J+4
      GO TO 905
 1200 DECODE(80,9010,HOL)MT,(SYMDIS(MT,J),J=1,7)
 9010 FORMAT(10X,I5,7F5.2)
      GO TO 50
 1300 DECODE(80,9010,HOL)IWT,(SYMDDF(IWT,J),J=1,7)
      GO TO 50
 1400 DECODE(80,9010,HOL)IWT,(SYMDIF(IWT,J),J=1,7)
      GO TO 50
 1500 DECODE (80,9011,HOL) MT,SECON(MT),SECOFF(MT),KOUNT(MT),IRNK(MT)
 9011 FORMAT (10XI5,2F5.2,2I5)
      INTIME(MT)=1
      GO TO 50
 1600 DECODE(80,9094,HOL)NUMDEF,IWTDEF(NUMDEF),XODEF(NUMDEF),
     *YODEF(NUMDEF),(NDEFEA(J,NUMDEF),J=1,15)
 9094 FORMAT(5X,2I5,2F10.2,15I2)
      GO TO 50
 1700 DECODE(80,9093,HOL)NDF,IROAD,(XYMS(I),I=1,4)
 9093 FORMAT(5X,2I5,4F10.2)
      L=0
      DO 1705 I=1,2
      ND=ND+1
      IXYM1=IFIX(XYMS(I+L)*100.)
      XRDFO(ND)=FLOAT(IXYM1+ISIGN(1,IXYM1)*IROAD)
      IXYM2=IFIX(XYMS(I*2)*100.)
      YRDFO(ND)=FLOAT(IXYM2+ISIGN(1,IXYM2)*NDF)
      L=L+1
 1705 CONTINUE
      GO TO 50
 1800 DECODE(80,9016,HOL)I1,J1,PHD(I1,J1),I2,J2,P2,I3,J3,P3,
     *I4,J4,P4,I5,J5,P5
 9016 FORMAT(5X,5(2I5,F5.2))
      IF(I2.LT.1) GO TO 50
      PHD(I2,J2)=P2
      IF(I3.LT.1)GO TO 50
      PHD(I3,J3)=P3
      IF(I4.LT.1)GO TO 50
      PHD(I4,J4)=P4
      IF(I5.LT.1) GO TO 50
      PHD(I5,J5)=P5
      GO TO 50
 1900 DECODE(80,9017,HOL)I1,J1,N1,EV1,I2,J2 N2,EV2,I3,J3,N3,EV3
 9017 FORMAT(5X,3(3I5,F10.2))
      EI(I1,J1,1)=N1
      EI(I1,J1,2)=EV1
      IF(I2.LT.1) GO TO 50
      EI(I2,J2,1)=N2
      EI(I2,J2,2)=EV2
      IF(I3.LT.1) GO TO 50
      EI(I3,J3,1)=N3
      EI(I3,J3,2)=EV3
      GO TO 50
 2000 DECODE(80,9050,HOL) NDFTYP,DEFL(NDFTYP),DEFW(NDFTYP),
     *DEFRAD(NDFTYP),DEFHT(NDFTYP),TMBRD(NDFTYP),NRAD(NDFTYP),
     *(ITGTPR(NDFTYP,I),I=1,5)
 9050 FORMAT(5X,I5,4F10.2,F5.2,I5,5I1)
      GO TO 50
 2100 DECODE(80,9051,HOL) I1,AI1,AREP1,ADEP1,I2,AI2,AREP2,ADEP2
 9051 FORMAT(5X,I5,3F10.2,5X,I5,3F10.2)
      AI(I1)=COS(AI1*.01745329)
      AREP(I1)=AREP1
      ADEP(I1)=ADEP1
      IF(I2.LT.1) GO TO 50
      AI(I2)=COS(AI2*.01745329)
```

Figure 30. (Continued)

```
      AREP(I2)=AREP2
      ADEP(I2)=ADEP2
      GO TO 50
 2200 DECODE(80,9052,HOL) I,J,K,N,AEV,ARELI,ACEPI
 9052 FORMAT(5X,4I5,F10.2,F5.2,F10.2)
      AE(I,J,2*K-1)=N
      AE(I,J,2*K)=AEV
      L=I
      IF(K.GT.1) L=J
      AREL(L,K)=ARELI
      IF(N.GT.1) ACEP(L,K)=ACEPI
      GO TO 50
 2300 DECODE(80,9053,HOL) I1,J1,K1,IDP1,I2,J2,K2,IDP2,I3,J3,K3,IDP3
 9053 FORMAT(5X,3(4I5,5X))
      IDP(I1,J1,K1)=IDP1
      IF(I2.LT.1) GO TO 50
      IDP(I2,J2,K2)=IDP2
      IF(I3.LT.1) GO TO 50
      IDP(I3,J3,K3)=IDP3
      GO TO 50
 2400 DECODE(80,9029,HOL)ILCFTT,DBFAE,DFTFAE,RADFAE,ALNGLC,
     *AWIDLC,TMDLCF,PDLCF
 9029 FORMAT(5X,I5,7F10.2)
      GO TO 50
 6900 DECODE(80,9008,HOL) NT,NM,NTB,(PROBTP(I),I=1,8)
 9008 FORMAT(1X,I1,I2,I1,F5.2,7F10.2)
      READ(4,9008) NT,NM,NTB,(RANGTP(I),I=1,8)
      NTABLE=(NT-1)*21+(NM-1)*3+NTB
      LL=8*(NTABLE-1)
      DO 6910 I=1,8
      PROBIL(LL+I)=PROBTP(I)
 6910 RANGPR(LL+I)=RANGTP(I)
      GO TO 50
C
C     PERFORM INITIAL CALCULATIONS
C
 7000 DO 7005 I=1,NMT
      XCYCLE(I)=SECON(I)+SECOFF(I)
      NMIN(I)=0
      DO 7005 J=1,NAP
      IF(MTFA(J).EQ.I) NMIN(I)=NMIN(I)+NSTICK(J)
 7005 CONTINUE
      IRTFIR=0
      DO 7006 I=1,5
      IF(NRAI(I).LT.1) GO TO 7006
      IRTFIR=1
 7006 NITBT(I)=0
      NGTAWT=0
      DO 7008 I=1,NTGO
      N=NTGTYP(I)
      NGTAWT=NGTAWT+NGTAW(I)
 7008 NITBT(N)=NITBT(N)+1
      IF(ISYMP(1).LT.1) GO TO 7015
      SYMMAX(1)=0.
      DO 7010 I=1,NMT
      DO 7010 J=1,7
      SYMDIS(I,J)=SYMDIS(I,J)**2
 7010 SYMMAX(1)=AMAX1(SYMMAX(1),SYMDIS(I,J))
      SYMMAX(1)=SQRT(SYMMAX(1))
 7015 RSPMAX=0.
      IF(ISYMP(2).LT.1) GO TO 7017
      SYMMAX(2)=0.
      DO 7016 I=1,5
      DO 7016 J=1,7
      SYMDDF(I,J)=SYMDDF(I,J)**2
 7016 SYMMAX(2)=AMAX1(SYMMAX(2),SYMDDF(2))
      SYMMAX(2)=SQRT(SYMMAX(2))
 7017 IF(ISYMP(3).LT.1) GO TO 7019
      SYMMAX(3)=0
      DO 7018 I=1,5
      DO 7018 J=1,7
      SYMDIF(I,J)=SYMDIF(I,J)**2
```

Figure 30. (Continued)

```
7018 SYMMAX(3)=AMAX1(SYMMAX(3),SYMDIF(I,J))
     SYMMAX(3)=SQRT(SYMMAX(3))
7019 IF(NMT.LT.1) GO TO 7045
     DO 7040 I=1,NTGTP
     RSP(I)=0.
     DO 7035 J=1,NMT
     NT=(I-1)*21+(J-1)*3
     DO 7030 K=1,3
     NT1=8*(NT+K-1)
     DO 7070 L=1,8
     IF(PROBIL(NT1+L).EQ.0.) GO TO 7022
7070 CONTINUE
7022 RNGSV(K)=RANGPR(NT1+L)
7030 CONTINUE
     PRSWDO(I,J)=RNGSV(1)
     PRKLO(I,J)=RNGSV(2)
     PRDTNO(I,J)=RNGSV(3)
     RSP(I)=AMAX1(RSP(I),RNGSV(1),RNGSV(3))
     RSPMAX=AMAX1(RSPMAX,RNGSV(1),RNGSV(3))
7035 CONTINUE
     IF(MADIV.GT.0) RSP(I)=RSP(I)+30.
7040 CONTINUE
     IF(MADIV.GT.0) RSPMAX=RSPMAX+30.
7045 XMIN=XMAX=0.
     DO 7060 I=1,5
7060 NIDBT(I)=0
     NDFWT=0
     IF(NDFWD.LT.1)GO TO 7085
     DO 7075 I=1,NDFWD
     N=IWTDEF(I)
7075 NIDBT(N)=NIDBT(N)+1
     DO 7080 I=1,5
     IF(NIDBT(I).GT.0) NDFWT=NDFWT+1
7080 CONTINUE
7085 CONTINUE
     DO 7100 I=1,NTGO
     XMAX=AMAX1(XMAX,TOTXOL(J))
7100 XMIN=AMIN1(XMIN,TOTXOL(I))
     XMAX=XMAX+RSPMAX
     XMIN=XMIN-RSPMAX
     IF (XMAX.GT.1638.) XMAX=1638.
     IF (XMIN.LT.-1638.) XMIN=-1638.
     IF(NVAP.LT.1) GO TO9998
     DO 8200 I=1,NVAP
     COSA=COS(AYYVP(I)*.01745329258)
     SINA=SIN(AYYVP(I)*.01745329258)
     XORGVP=FLOAT(IFIX(XOVP(I)/100.))/100.
     YORGVP=YOVP(I)
     NWV=NWEPV(I)
     IF(NWV.LT.1)GO TO 8200
     DO 8190 J=1,NWV
     XDMP(I,J)=XORGVP+DMP1IX(I,J)*COSA+DMP1IY(I,J)*SINA
     YDMP(I,J)=YORGVP+DMP1IY(I,J)*COSA-DMP1IX(I,J)*SINA
8190 CONTINUE
8200 CONTINUE
     DO 8500 I=1,NTGTP
     AM=AMAX1(TARL(I),TARW(I))
     DO 8500 J=1,NVAP
     K=IWTVAP(J)
     THRSIG(K,I)=(4.44*AMAX1(REP(J),DEP(J))+AM*SQRT(E1(K,1,2)))**2
8500 CONTINUE
9998 RETURN
1480 FORMAT(1H1)
     END
```

Figure 30. (Continued)

```
      SUBROUTINE SETUP
C
C     RETURN POINT TO BEGIN EACH MONTE-CARLO ITERATION
C
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPTX(50),AIMPIY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUDPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LOFDPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NDVT,NGTAW(100),NGTAWT,NGTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),PDLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PROTNO(5,7),PRKLU(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C****
      IT = 0
      TGTSPD=TGTVL2
      IF(MODE.LT.3)TGTSPD=TGTOVL
      REWIND 1
      REWIND 2
      IRUNS=IRUNS+1
      DO 300 I=1,5
      NKILLI(I)=NKILLD(I)=NRFBIT(I)=NRFBDT(I)=NDFDAM(I)=0
  300 NKILL(I)=0
      DO 305 I=1,NVAP
      NVLIDF(I)=NVFAEA(I)
  305 CONTINUE
      DO 310 I=1,7
  310 NMSWPT(I)=NMDET(I)=MIFBT(I)=0
      DO 315 J=1,20
      DO 315 I=1,15
  315 NDEFEA(I,J)=IABS(NDEFEA(I,J))
      DO 320 J=1,15
      ISVIFA(J+15)=0
  320 ISVIFA(J)=0
      DO 325 J=1,130
  325 TMTOFR(J)=9990.
      DO 330 I=1,100
      KDFTIN(I)=0
      NRFIRD(I)=0
  330 DELATM(I)=0.
      NKILLT=NSPLFT=0
      NTLOST=0
      NOBEVT=1
      THET=.017453295*THETA
      SINT=SIN(THET)
      COST=COS(THET)
      KNRS=0
      XW2=XWIDTH/2.0
      YL2=YLENGTH/2.0
      DO 210 I=1,547
  210 KABOOM(I)=0
```

Figure 30. (Continued)

```
      NOB = 0
      NOBTP2=8
      IT=0
      N=NRS+1
      NOB=NOB+N
      DO 200 I=1,N
  200 WRITE(1) XROAD(I),YROAD(I),NOBTP2,IT
      IF(NAP.LT.1) GO TO 160
      DO 146 J=1,NAP
  147 CALL RNORM(RN1)
      CALL RNORM(RN2)
      REWIND 2
      MT=MTFA(J)
      IT=0
      N=NSTICK(J)
      DO 146 I=1,N
      CALL RNORM(RN3)
      CALL RNORM(RN4)
      NOBTP2=MT
      IF(JSELDS(MT)) 120,130
  130 READ(2) ORX,ORY,NOBTP2
      IF(NOBTP2.NE.MT) GO TO 130
      GO TO 150
  120 GO TO(122,125,125,122),JSELDS(MT)
  122 CALL RNORM(RSTART)
      ORX=XSWATH(J)/6.*RSTART
      IF(JSELDS(MT)-4) 123,126,123
  123 CALL RNORM(RSTART)
      ORY=YSWATH(J)/6.*RSTART
      GO TO 150
  125 ORX=XSWATH(J)*(RANF(DUMMY)-.5)
      IF(JSELDS(MT)-3) 126,123,126
  126 ORY=YSWATH(J)*(RANF(DUMMY)-.5)
  150 ORX=ORX+RN1*SIGAD(J)+RN3*SIGBD(J)
      ORY=ORY+RN2*SIGAR(J)+RN4*SIGBR(J)
      OBX=AIMPTX(J)+ORX*COST+ORY*SINT
      OBY=AIMPTY(J)-ORX*SINT+ORY*COST
      IF(ABS(OBX).GT.XW2.OR.ABS(OBY).GT.YL2) GO TO 146
143   RN = RANF( DUMMY )
      IF(RN-DUDPRB(MT)) 20,20,25
   20 NOBTP2=NOBTP2+8
   25 IF(INTIME(MT).EQ.0) GO TO 145
      RN = RANF (DUMMY)
      IT=RN*XCYCLE(MT)
      IF (KOUNT(MT).GT.0) IT=KOUNT(MT)
      IF (IRNK(MT).GT.0) IT=IFIX(IT*RN)+1
  145 IF(MODE.EQ.1.AND.NOBTP2.GT.8) GO TO 146
      NOB = NOB + 1
      WRITE(1) OBX,OBY,NOBTP2,IT
146   CONTINUE
      IF(NOB.LE.32767) GO TO 160
      PRINT 1000
 1000 FORMAT(* MORE THAN 32767 MINES IN MINEFIELD*)
      CALL EXIT
  160 NOBTP2=0
      WRITE(1) OBX,OBY,NOBTP2,IT
10    MUSH = 0
      TOTSIM = 0.0
      DO 100 I=1,NTGO
      N=NTGTYP(I)
      NRADFI(I)=NRAI(N)
      IF(NTTTCS(N).EQ.1) NSPLFT=NSPLFT+1
99    TIMEMV(I)=0.
      TGTDEL(I)=0.
      SWPDEL(I)=0.
      NGTAWI(I)=NGTAW(I)
      TGTVEL(I)=TGTSPD
100   CONTINUE
      DO 110 J=1,NDFWD
      N=IWTDEF(J)
      NRADFD(J)=NRAD(N)
  110 CONTINUE
      RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE ROAD
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNOLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUDPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LOFDPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAH(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFHD,NDFWT,NDVT,NGTAW(100),NGTAWT,NGTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),PDLCF
      COMMON PHD(5,5),PPFAF(7),PRBITY,PRDTNO(5,7),PRKLO(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C****
      DIMENSION XLCF(100)
      NDFA=INDFA=0
      REWIND 1
      KNRS=KNRS+1
      DO 10 I=1,KNRS
   10 READ(1) XR1,YR1,NOBTP2,II
      READ(1) XR2,YR2,NOBTP2,II
   20 READ(1) ORX,ORY,NOBTP2,II
      IF(NAP.LT.1) GO TO 25
      IF(NOBTP2.EQ.8) GO TO 20
   25 N2=NOBTP2
      LIT=II
      A1=YR2-YR1
      A2=XR2-XR1
      IF(A2.EQ.0.) A2=.0000001
      THETR=ATAN2(A1,A2)-3.141592654/2
      COSTR=COS(THETR)
      SINTR=SIN(THETR)
      OBX=0.0
      OBY=0.0
      NOBTP2=8
      IT=IMINE=0
      CALL IPACK
      IOB(1)=IWORD
      YLENTH=OBY=SQRT(A2**2+A1**2)
      CALL IPACK
      NOB=2
      IOB(2)=IWORD
      NOBTP2=N2
      IT=LIT
      DO 45 I=1,130
   45 TMTOFR(I)=9999.0
      YMIN=99999.
      YMAX=0.
      DO 50 IMINE=1,32767
      IF(NOBTP2.EQ.0) GO TO 100
      OBX=(ORX-XR1)*COSTR+(ORY-YR1)*SINTR
      OBY=-(ORX-XR1)*SINTR+(ORY-YR1)*COSTR
      IF(OBY.GT.YLENTH.OR.OBY.LE.0.) GO TO 40
      IF(OBX.LT.XMIN.OR.OBX.GT.XMAX) GO TO 40
```

Figure 30. (Continued)

```
      YMIN=AMIN1(YMIN,OBY)
      YMAX=AMAX1(YMAX OBY)
      IDET=0
      IF(KNRS.GT.1) CALL BOOM(IDET,2)
      IF(IDET.EQ.1) GO TO 40
      CALL IPACK
      M=MOD(NOBTP2,8)
      IF(NOBTP2.GT.15)GO TO 29
      MIFBT(M)=MIFBT(M)+1
   29 NOB=NOB+1
      IF(NOB.LT.5001) GO TO 30
      PRINT 1000
 1000 FORMAT(*0MORE THAN 5000 MINES WITHIN RANGE OF INFLUENCE FOR A ROA
     *D SEGMENT*/20(1H/),*PROGRAM STOPS*,20(1H/))
      CALL EXIT
   30 IOB(NOB)=IWORD
   40 READ(1) ORX,ORY,NOBTP2,IT
   50 CONTINUE
  100 DO 120 I=1,NTGO
      KTSAV(I)=1
      IF(KNRS.EQ.1) GO TO 110
      IF(TGTYNW(I).GT.99994.) GO TO 120
  110 TGTYNW(I)=TGTYOL(I)
      TGTVEL(I)=TGTSPD
      IF(KNRS.EQ.1) GO TO 120
      TADJ=ABS(TGTYNW(I)/TGTVEL(I))
      DELTM=TGTDEL(I)+SWPDEL(I)
      TIMEMV(I)=TIMEMV(I)-TADJ-DELTM
      TGTYNW(I)=TGTYNW(I)-TGTVEL(I)*DELTM
  120 CONTINUE
      TGTYSV=TGTYOL(1)
      LEFTIN=NTGO-NKILLT-NTLOST
      MUSH=0
      NDVT=0
      DO 121 I=1,100
  121 S(I)=0.
      ISVLST=1
      KTSAV(1)=0
      IF(NVAP.LT.1) GO TO 135
      IMINE=IT=0
      NOBTP2=16
      DO 130 J=1,NVAP
      DIRATK(J)=AYYVP(J)*.017453293-THETR
      IRD=AMOD(XOVP(J),100.)
      IROAD=IABS(IRD)
      IF(IROAD.NE.KNRS) GO TO 130
      IT=NTLCIF(J)
      IMINE=J
      XR=(XOVP(J)-IROAD)/10000.
      YR=YOVP(J)
      OBX=(XR-XR1)*COSTR+(YR-YR1)*SINTR
      OBY=-(XR-XR1)*SINTR+(YR-YR1)*COSTR
      IF(OBY.GT.YLENTH.OR.OBY.LE.0.) GO TO 125
      IF(OBX.LT.-1638..OR.OBX.GT.1638.) GO TO 125
      CALL IPACK
      NOB=NOB+1
      IF(NOB.LT.5001) GO TO 124
      PRINT 1000
      CALL EXIT
  124 IOB(NOB)=IWORD
  125 CONTINUE
  130 CONTINUE
      DO 134 J=1,NVAP
      NWV=NWEPV(J)
      IF(NWV.LT.1) GO TO 134
      DO 133 K=1,NWV
      ROTDMPX(J,K)=(XDMP(J,K)-XR1)*COSTR+(YDMP(J,K) YR1)*SINTR
      ROTDMPY(J,K)=-(XDMP(J,K)-XR1)*SINTR+(YDMP(J,K)-YR1)*COSTR
  133 CONTINUE
  134 CONTINUE
  135 IMINE=0
      IT=0
```

Figure 30. (Continued)

```
      L=0
      IF(ND.LT.1) GO TO 160
      DO 150 I=1,ND
      IRD=AMOD(XRDFO(I),100.)
      IRD=IABS(IRD)
      IF(IRD.NE.KNRS) GO TO 150
      XR=FLOAT(IFIX(XRDFO(I)/100.))
      YR=FLOAT(IFIX(YRDFO(I)/100.))
      OBY=-(XR-XRI)*SINTR+(YR-YRI)*COSTR
      IF(OBY.GT.YLENTH.OR.OBY.LE.0.) GO TO 150
      NOBTP2=17
      IF(L)149,147
  147 L=1
      IT=IFIX(AMOD(YRDFO(I),100.))
      IT=IABS(IT)
  148 CALL IPACK
      NOB=NOB+1
      IF(NOB.LT.5001) GO TO 140
      PRINT 1000
      CALL EXIT
  149 NOBTP2=18
      L=0
      GO TO 148
  140 IOB(NOB)=IWORD
  150 CONTINUE
  160 IF(NDFAA.LT.1) GO TO 400
      DO 350 I=1,NDFWD
      DEFX(I)=(XODEF(I)-XRI)*COSTR+(YODEF(I)-YRI)*SINTR
      DEFY(I)=-(XODEF(I)-XRI)*SINTR+(YODEF(I)-YRI)*COSTR
350   CONTINUE
  400 IF(LCFOPT.LT.1)RETURN
      NLCFCT=0
      DO 410 I=1,NTGO
      IF(NTGTYP(I).NE.LCFTT) GO TO 410
      NLCFCT=NLCFCT+1
      XLCF(NLCFCT)=TGTXOI(I)
  410 CONTINUE
      DLCF=ALNGLC
      IF(LCFOPT.GT.1)DLCF=DBFAE
      II=0
      IMINE=0
      NOBTP2=19
      OBY=YMIN-2.*DLCF
      OBY=AMAX1(OBY,0.)
  420 OBY=OBY+DLCF
      IF(OBY.GT.YMAX) GO TO 500
      DO 430 I=1,NLCFCT
      OBX=XLCF(I)
      CALL IPACK
      NOB=NOB+1
      IOB(NOB)=IWORD
      IF(NOB.LT.5001) GO TO 430
      PRINT 1000
      CALL EXIT
  430 CONTINUE
      GO TO 420
  500 RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE BOOM(IDET,N)
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNOLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUOPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LDFDPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NDVT,NGTAW(100),NGTAWT,NGTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),POLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PRDTND(5,7),PRKLO(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C****
      IWD=(IMINE-1)/60+1
      K=MOD(IMINE,60)-1
      IF(K.EQ.-1) K=59
      IF(N.GT.1) GO TO 200
  100 I=1
      KABOOM(IWD)=KABOOM(IWD).OR.SHIFT(I,K)
      RETURN
  200 IDET=SHIFT(KABOOM(IWD),-K).AND.1B
      RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE SORT(A,N)
C
C     ..................................................................
C
C        SUBROUTINE SORT
C
C     PURPOSE
C        TO SORT A VECTOR INTO INCREASING ORDER FROM A(1) TO A(N).
C        A MAY BE TYPE REAL OR TYPE INTEGER.
C
C     USAGE
C        CALL SORT(A,N)
C
C     DESCRIPTION OF PARAMETERS
C        A       - THE NAME OF THE N-VECTOR TO BE SORTED
C                - IF A IS TYPE REAL THEN EACH OF ITS COMPONENTS
C                - MUST BE IN NORMALIZED FORM.
C        N       - THE NUMBER OF ELEMENTS IN THE VECTOR TO BE SORTED
C
C     REMARKS
C        THE PROCEDURE REQUIRES TWO ADDITIONAL ARRAYS IU(K) AND IL(K)
C        WHICH PERMIT SORTING UP TO 2**(K+1)-1 ELEMENTS   THESE
C        ARRAYS ARE SUPPLIED BY THE SUBROUTINE WITH K= 16.  THIS
C        ALLLOWS SORTING A MAXIMUM OF 131071 ELEMENTS.
C
C     METHOD
C        AN EFFICIENT ALGORITHIM FOR SORTING WITH MINIMAL STORAGE
C        BY RICHARD C. SINGLETON
C        PREPARED FOR
C        INSTITUTE RESEARCH AND DEVELOPMENT
C        STANFORD RESEARCH INSTITUTE PROJECT 387531-132
C        SEPTEMBER 1968.
C
C     ..................................................................
C
      INTEGER A(N),IU(16),IL(16),T,TT
      M = 1
      I = 1
      J = N
    5 IF(I-J) 10,70,70
   10 K = I
      IJ = (J+I)/2
      T = A(IJ)
      IF(A(I)-T) 20,20,15
   15 A(IJ) = A(I)
      A(I) = T
      T = A(IJ)
   20 L = J
      IF(A(J)-T) 23,40,40
   23 A(IJ) = A(J)
      A(J) = T
      T = A(IJ)
      IF(A(I)-T) 40,40,27
   27 A(IJ) = A(I)
      A(I) = T
      T = A(IJ)
      GO TO 40
   30 A(L) = A(K)
      A(K) = TT
   40 L = L - 1
      IF(A(L)-T) 35,35,40
   35 TT = A(L)
   50 K = K + 1
      IF(A(K)-T) 50,53,53
   53 IF(K-L) 30,30,55
   55 IF((L-I)-(J-K)) 60,60,57
   57 IL(M) = I
      IU(M) = L
      I = K
      M = M + 1
      GO TO 80
   60 IL(M) = K
```

Figure 30. (Continued)

```
      IU(M) = J
      J = L
      M = M + 1
      GO TO 80
   70 M = M - 1
      IF(M) 75,110,75
   75 I = IL(M)
      J = IU(M)
   80 IF(J-I-11) 85,10,10
   85 IF(I-1) 87,5,87
   87 I = I -1
   90 I = I + 1
      IF(I-J) 93,70,93
   93 T = A(I+1)
      IF(A(I)-T) 90,90,97
   97 K = I
  100 A(K+1) = A(K)
      K = K - 1
      IF(T-A(K)) 100,105,105
  105 A(K+1) = T
      GO TO 90
  110 RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE LOOPS
C
      COMMON ACEP(5.2).ADEP(20).AEI(5.5.4).AI(20).AIMPTX(50).AIMPTY(50).
     .ALNGLC.ANGIMP(10).AREL(5.2).AREP(20).AWIDLC.AYYVP(10).DBFAE.
     .DEFHT(5).DEFL(5).DEFRAD(5).DEFW(5).DEFX(20).DEFY(20).DELATM(100).
     .DEP(10).DFTFAE.DIRATK(10).DIRDIS(100).DMPIIX(10.10).DMPIIY(10.10)
     .DUDPRB(7).D3DEL.EI(5.5.2).ID.IDISOP.IDP(20.15.2).IEND.
     .IIS.IMINE.INDFA.INTIME(7).IOB(5000).IPO.IPRINT.IRNK(7).IPTFIR.
     .IRUNS.ISAVE.ISBL.ISVIFA(30).ISVLST.ISYMP(3).ISYP.IT.ITEROP.
     .ITGTPR(5.5).IVAP.IVEL.IWORD.IWTDEF(20).IWTVAP(10)
      COMMON JMARKI.JSELDS(7).KABOOM(547).KDFTIN(100).KNRS.KOUNT(7).
     .KTSAV(100).KI.LCFOPT.LCFTT.LDFDPR(5.5).LEFTIN.MADIV.MIFBT(7).
     .MODE.MTFA(50).MUSH.NAP.NCTAW(100).ND.NDEFEA(15.20).NDF.NDFA.
     .NDFAA.NDFDAM(5).NDFHD.NDFWT.NDVT.NGTAW(100).NGTAWT.NGTAWI(100).
     .NIDBT(5).NIIBT(5).NKILL(5).NKILLD(5).NKILLI(5).NKILLT.NMDET(7).
     .NMIN(7).NMSWPT(7).NMT.NOB.NOBEVT.NOBTP2.NOIT.NOSTAT.NRAD(5).
     .NRADFD(20).NRADFI(100).NRAI(5).NRBA.NRFBDT(5).NRFBIT(5).
     .NRFIRD(100).NRS.NSPLFT.NSTICK(50).NSUB(5).NTCOL(100).NTGO.NTGIP.
     .NTGTYP(100).NTLCIF(10).NTLOST.NTTTCS(5).NTTTMD(5).NTTTRP(5).NVAP.
     .NVFAEA(10).NVLIDF(10).NWEPV(10).OBX.OBY.OBYPRT.PATRAD(5).PDLCF
      COMMON PHD(5.5).PPEAF(7).PRBITY.PRDTND(5.7).PRKLO(5.7).
     .PROBIL(840).PRSWDO(5.7).RADFAE.RANGPR(840).RELRND(5).RELSUB(5).
     .REP(10).RN.ROTDMPX(10.10).ROTDMPY(10.10).RSP(5).S(100).SECON(7).
     .SIGAD(50).SIGAR(50).SIGBD(50).SIGBR(50).STATAL(5.52).SWPDEL(100).
     .SYMDDF(5.7).SYMDIF(5.7).SYMDIS(7.7).SYMMAX(3).TARHT(5).TARL(5).
     .TARRAD(5).TARW(5).TDBIFV(10).TGTDEL(100).TGTOVL.TGTSPD.
     .TGTVEL(100).TGTVL2.TGTVSV.TGTXOL(100).TGTYNW(100).TGTYOL(100).
     .TGTYSV.THETA.THRSIG(5.5).TIMEMV(100).TMBRD(5).TMBRI(5).TMDLCF.
     .TMSWP(7).TMTOFR(130).TOTSIM.TRAVTM.XCYCLE(7).XDMP(10.10).XFIX.
     .XMAX.XMIN.XODEF(20).XOVP(10).
     .XRDFO(30).XROAD(11).XSWATH(50).XWIDTH.YDIV(100).YDMP(10.10).
     .YLENGTH.YODEF(20).YOVP(10).YRDFO(30).YROAD(11).YSWATH(50)
C.....
      DIMENSION IPOS(100).TM(100)
      KTSAV(ISVLST)=KTSAV(ISVLST)+1
      DO 250 I=1.NTGO
      IF(TGTYNW(I)-100000.)110.110.100
  100 TGTYNW(I)=99999.
      TMTOFR(I)=9990.
      DIRDIS(I)=99999.
      GO TO 250
  110 DIRDIS(I)=99999.
      IF(TGTYNW(I).GT.99970.) GO TO 250
  140 KT=KTSAV(I)
      IF(IOB(KT)+1) 210.205
  205 KTSAV(I)=KTSAV(I)+1
      GO TO 140
  210 IWORD=IOB(KT)
      CALL UNPACK
      N=NTGTYP(I)
      IF(NOBTP2.GT.15) GO TO 240
      M=MOD(NOBTP2.8)
      IF(M) 212.240
  212 IF(PRSWDO(N.M))220.215
  215 IF(PRDTND(N.M))220.205
  220 XDIS=ABS(OBX-TGTXOL(I))
      IF(XDIS-RSP(N))240.205.205
  240 DIRDIS(I)=OBY-TGTYNW(I)
  250 CONTINUE
      ISAVE=1
      IVEL=0
      ISV=1
      SMLDIS=SMLDISI=99999.
      DO 400 I=1.NTGO
      IF(SMLDIS-DIRDIS(I))350.350.310
  310 ISAVE=I
      SMLDIS=DIRDIS(I)
  350 IF(TGTVEL(I))360.400.360
  360 IF(SMLDISI-DIRDIS(I))400.400.380
  380 SMLDISI=DIRDIS(I)
      ISV=I
      IVEL=1
```

Figure 30. (Continued)

```
400 CONTINUE
    TRAVTM=SMLDIS/TGTSPD
    ISVLST=ISAVE
    IF(TGTVEL(ISAVE).GT.0.)RETURN
    IF(IVEL.LT.1) GO TO 580
    TT=SMLDIS1/TGTSPD
    IF(TT.LE.DELATM(ISAVE))GO TO 570
    TRAVTM=DELATM(ISAVE)
    RETURN
570 ISAVE=ISV
    ISVLST=ISV
    TRAVTM=TT
    RETURN
580 DO 590 I=1,NTGO
    TM(I)=DELATM(I)
    IPOS(I)=I
    IF(TGTYNW(I).GT.99990.)TM(I)=99999.
590 CONTINUE
    DO 700 I=1,NTGO
    IF(I.LT.2)GO TO 600
    IF(TM(I-1).GT.TM(I))GO TO 710
600 K=I
    DO 700 J=I,NTGO
    IF(TM(I).LT.TM(J))GO TO 700
    SAVE=TM(I)
    TM(I)=TM(J)
    TM(J)=SAVE
    KEEP=IPOS(I)
    IPOS(I)=IPOS(J)
    IPOS(J)=KEEP
700 CONTINUE
710 NUM=K-1
    DIS=99999.
    DO 750 I=1,NUM
    KPOS=IPOS(I)
    IF(DIRDIS(KPOS).GT.DIS) GO TO 750
    DIS=DIRDIS(KPOS)
    ISAVE=KPOS
750 CONTINUE
    ISVLST=ISAVE
    TRAVTM=TM(1)
    RETURN
    END
```

Figure 30. (Continued)

```
      SUBROUTINE EVENTC
C
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUDPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTIN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFIT,LDFDPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MIFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFHD,NDFWT,NOVT,NGTAW(100),NGTAWT,NOTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLO(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFACA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),POLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PRDTNO(5,7),PRKLD(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANDPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C****
      TGTVSV=TGTVEL(ISAVE)
      OBYPRT=OBY
      OBY=99999.
      IOB(1)=-1
      MUSH=1
      IF(KNRS.NE.1) GO TO 1000
      TOTSIM=0.
      DO 200 I=1,NTGO
  200 TIMEMV(I)=0.
      GO TO 1000
  505 CONTINUE
      TGTYSV = TGTYNW(ISAVE)
      LEFTIN = LEFTIN - 1
 502  TGTYNW(ISAVE)=99991.
      IF(NDFA.LT.1) GO TO 511
      TMTOFR(ISAVE)=9990.
      DO 510 J=1,NDFA
      CALL STINT(ISVIFA,ISAVE,J,IBIT,KDFTIN,2)
  510 CONTINUE
  511 IF(KNRS.NE.NRS) GO TO 512
      N=NTGTYP(ISAVE)
      IF(NTTTCS(N).EQ.1) NSPLFT=NSPLFT-1
 512  TOTVEL(ISAVE)=0
 1000 RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE DIVSET
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10) DMPIIY(10,10),
     *DUDPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LDFDPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NDVT,NGTAW(100),NGTAWT,NGTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),PDLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PRDTNO(5,7),PRKLO(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C....
      K=KI
      IF(XFIX) 50,10,100
   10 NDVT=NDVT+1
      YDIV(NDVT)=TGTYNW(K)
      NTCOL(NDVT)=NCTAW(K)
      S(NDVT)=-1.
      GO TO 500
   50 S(ID)=1.
      GO TO 500
  100 S(ID)=999.
      DO 200 I=1,NTGO
      IF(TGTYNW(I).GT.99990.) GO TO 200
      IF(NTCOL(ID).NE.NCTAW(I)) GO TO 200
      IF(TGTYNW(I).GT.YDIV(ID)+60.) GO TO 200
      TGTDEL(I)=TGTDEL(I)+D3DEL
      DELATM(I)=D3DEL
      TGTVEL(I)=0.
  200 CONTINUE
  500 RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE DIVCHK
      COMMON ACEP(5.2),ADEP(20),AEI(5.5.4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNGLC,ANGIMP(10),AREL(5.2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10.10),DMPIIY(10.10),
     *DUDPRB(7),D3DEL,EI(5.5.2),ID,IDISOP,IDP(20.15.2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5.5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LDFDPR(5.5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15.20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFHT,NDVT,NGTAW(100),NGTAWT,NGTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),PDLCF
      COMMON PHD(5.5),PPEAF(7),PRBITY,PRDTNO(5.7),PRKLO(5.7),
     *PROBIL(840),PRSWDO(5.7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10.10),ROTDMPY(10.10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5.52),SWPDEL(100),
     *SYMDDF(5.7),SYMDIF(5.7),SYMDIS(7.7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5.5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10.10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10.10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C****
      K=K1
      DO 50 I=1,NDVT
      ID=1
      IF(NCTAW(K).NE.NTCOL(I)) GO TO 50
      T1=TGTYNW(K)
      T2=YDIV(I)+60.
      T3=YDIV(I)-60.
      IF(T1.LT.T3.OR.T1.GT.T2) GO TO 50
      IF(S(I).EQ.999.) GO TO 50
   20 XFIX=S(I)*(SQRT(5625.-(T1-YDIV(I))**2)-45.)
      GO TO 100
   50 CONTINUE
  100 RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE UNIT
      COMMON ACEP(5.2).ADEP(20).AEI(5.5.4).AI(20).AIMPTX(50).AIMPTY(50).
     *ALNGLC.ANGIMP(10).AREL(5.2).AREP(20).AWIDLC.AYYVP(10).DBFAE.
     *DEFHT(5).DEFL(5).DEFRAD(5).DEFW(5).DEFX(20).DEFY(20).DELATM(100).
     *DEP(10).DFTFAE.DIRATK(10).DIRDIS(100).DMPIIX(10.10).DMPIIY(10.10).
     *DUDPRB(7).D3DEL.EI(5.5.2).ID.IDISOP.IDP(20.15.2).IEND.
     *IIS.IMINE.INDFA.INTIME(7).IOB(5000).IPO.IPRINT.IRNK(7).IRTFIR.
     *IRUNS.ISAVE.ISBL.ISVIFA(30).ISVLST.ISYMP(3).ISYP.IT.ITEROP.
     *ITGTPR(5.5).IVAP.IVEL.IWORD.IWTDEF(20).IWTVAP(10)
      COMMON JMARKI.JSELDS(7).KABOOM(547).KOFTTN(100).KNRS.KOUNT(7).
     *KTSAV(100).KI.LCFOPT.LCFTT.LDFDPR(5.5).LEFTIN.MADIV.MIFBT(7).
     *MODE.MTFA(50).MUSH.NAP.NCTAW(100).ND.NDEFEA(15.20).NDF.NDFA.
     *NDFAA.NDFDAM(5).NDFWD.NDFWT.NDVT.NGTAW(100).NGTAWT.NGTAWI(100).
     *NIDBT(5).NITBT(5).NKILL(5).NKILLD(5).NKILLI(5).NKILLT.NMDET(7).
     *NMIN(7).NMSWPT(7).NMT.NOB.NOBEVT.NOBTP2.NOIT.NOSTAT.NRAD(5).
     *NRADFD(20).NRADFI(100).NRAI(5).NRBA.NRFBOT(5).NRFBIT(5).
     *NRFIRD(100).NRS.NSPLFT.NSTICK(50).NSUB(5).NTCOL(100).NTGO.NTGTP.
     *NTGTYP(100).NTLCIF(10).NTLOST.NTTTCS(5).NTTTMD(5).NTTTRP(5).NVAP.
     *NVFAEA(10).NVLIDF(10).NWEPV(10).OBX.OBY.OBYPRT.PATRAD(5).PDLCF
      COMMON PHO(5.5).PPEAF(7).PRBITY.PRDTNO(5.7).PRKLO(5.7).
     *PROBIL(840).PRSWDO(5.7).RADFAE.RANGPR(840).RELRND(5).RELSUB(5).
     *REP(10).RN.ROTDMPX(10.10).ROTDMPY(10.10).RSP(5).S(100).SECON(7).
     *SIGAD(50).SIGAR(50).SIGBD(50).SIGBR(50).STATAL(5.52).SWPDEL(100).
     *SYMDDF(5.7).SYMDIF(5.7).SYMDIS(7.7).SYMMAX(3).TARHT(5).TARL(5).
     *TARRAD(5).TARW(5).TDBIFV(10).TGTDEL(100).TGTOVL.TGTSPD.
     *TGTVEL(100).TGTVL2.TGTVSV.TGTXOL(100).TGTYNW(100).TGTYOL(100).
     *TGTYSV.THETA.THRSIG(5.5).TIMEMV(100).TMBRD(5).TMBRI(5).TMDLCF.
     *TMSWP(7).TMTOFR(130).TOTSIM.TRAVTM.XCYCLE(7).XDMP(10.10).XFIX.
     *XMAX.XMIN.XODEF(20).XOVP(10).
     *XRDFO(30).XROAD(11).XSWATH(50).XWIDTH.YDIV(100).YDMP(10.10).
     *YLENGTH.YODEF(20).YOVP(10).YRDFO(30).YROAD(11).YSWATH(50)
C****
      DIMENSION NAS(100)
      DO 200 K=1.NTGO
      IF(TGTYNW(K).LT.100000.) GO TO 200
      L=0
      DO 10 I=1.NTGO
      IF(TGTYNW(I).GT.99990.) GO TO 10
      IF(NGTAWI(I).NE.K) GO TO 10
      L=L+1
      NAS(L)=I
   10 CONTINUE
      IF (L.EQ.0) GO TO 200
      KF=KB=0
      SMALY=99999.
      BIGY=-99999.
      DO 50 I=1.NTGO
      IF(I.EQ.K) GO TO 50
      IF(NCTAW(I).NE.NCTAW(K)) GO TO 50
      IF(NTGTYP(I).NE.NTGTYP(K)) GO TO 50
      IF(TGTYNW(I).GE.99999.) GO TO 50
      IF(TGTYNW(I).GT.TGTYNW(K)-100000.) GO TO 20
      IF(TGTYNW(I).LT.BIGY) GO TO 50
      KB=I
      BIGY=TGTYNW(I)
      GO TO 50
   20 IF(TGTYNW(I).GT.SMALY) GO TO 50
      KF=I
      SMALY=TGTYNW(I)
   50 CONTINUE
      IF(KF.EQ.0) GO TO 100
      DO 60 I=1.L
      NI=NAS(I)
   60 NGTAWI(NI)=KF
      GO TO 200
  100 IF(KB.EQ.0) GO TO 130
      YFIX=TGTYNW(K)-BIGY-100000.
      DO 110 I=1.L
      NI=NAS(I)
      TGTYNW(NI)=TGTYNW(NI)-YFIX
  110 NGTAWI(NI)=KB
      GO TO 200
```

Figure 30. (Continued)

```
  130 DO 150 I=1,L
      NI=NAS(I)
      TGTYNW(NI)=99995.
      TMTOFR(NI)=9990.
      IF(IRUNS.EQ.IPRINT)PRINT 99999,NI
99999 FORMAT(* TGT LOST *,I4)
      TGTVEL(NI)=0.
      LEFTIN=LEFTIN-1
      NTLOST=NTLOST+1
      IF(NDFA.LT.1) GO TO 150
      DO 140 J=1,NDFA
      CALL STINT(ISVIFA,NI,J,IBIT,KDFTIN,2)
  140 CONTINUE
  150 CONTINUE
  200 CONTINUE
      RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE TGTMIN
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUDPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LDFDPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NDVT,NGTAW(100),NGTAWT,NGTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),PDLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PRDTNB(5,7),PRKLB(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMOLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVIM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C....
      TGTYSV=TGTYNW(ISAVE)
      KT=KTSAV(ISAVE)
      IPO=1H
      OBYPRT=OBY
      XFIX=0.
      KI=ISAVE
      NOBEVT=-NOBEVT
      IF(NDVT.GT.0) CALL DIVCHK
      XFIXI=XFIX
      DISTPD=ABS(OBX-TGTXOL(ISAVE)-XFIX)
      N=NTGTYP(ISAVE)
      M=MOD(NOBTP2,8)
      IF(NTTTRP(N).GT.0) GO TO 649
      IF(NOBTP2.GT.15)RETURN
      IF(MODE.LT.3) GO TO 200
      IF(NTTTCS(N).LT.1) GO TO 200
      IF(DISTPD.GE.PRSWDO(N,M)) GO TO 200
      NTABLE=(N-1)*21+(M-1)*3+1
      CALL TABINT(DISTPD,NTABLE)
      NOBEVT=IABS(NOBEVT)
      RN=RANF(DUMMY)
      IF(RN.GT.PRBITY) GO TO 200
      IPO=5HSWEPT
      OBY=99987.
      NMSWPT(M)=NMSWPT(M)+1
      CALL BOOM(IDET,1)
      IOB(KT)=-1
      IF(NOBTP2.LT.8) NMDET(M)=NMDET(M)+1
      IF(ISBL.GT.0.AND.ISYMP(1).GT.0) CALL SYMDET
      DO 105 I=1,NTGO
      IF(TGTYNW(I).GT.99969.) GO TO 105
      IF(NCTAW(I).NE.NCTAW(ISAVE)) GO TO 105
      SWPDEL(I)=SWPDEL(I)+TMSWP(M)
      DELATM(I)=TMSWP(M)
      TGTVEL(I)=0.
  105 CONTINUE
      GO TO 700
  200 IF(INTIME(M).LT.1) GO TO 649
C
C     IF INTERMITTANT TIMER OPTION IS ON (INTIME=1), CHECK IF MINE IS
```

Figure 30. (Continued)

```
C       ACTIVE AT THE TIME OF CLOSEST APPROACH
C
        IF (KOUNT(M).GT.0) GO TO 649
        TOTSIM=TIMEMV(ISAVE)+TOTDEL(ISAVE)+SWPDEL(ISAVE)
        IF(AMOD(TOTSIM*60.+IT,XCYCLE(M)).GT.SECON(M)) RETURN
  649   CONTINUE
C
C       SEE IF MINE DETONATES
C
        PRBITY=0.
        IF(NOBTP2.GT.7) RETURN
        IF(DISTPD.GE.PRDTND(N,NOBTP2)) RETURN
        NTABLE=(N-1)*21+(NOBTP2-1)*3+3
        CALL TABINT(DISTPD,NTABLE)
        NOBEVT=IABS(NOBEVT)
        RN=RANF(DUMMY)
        IF (RN .LT. PRBITY) GO TO 650
        IF(NTTTRP(N).LT.2) RETURN
C
C     PLOWS ONLY SECTION
C
        IF(RANF(DUMMY).LT.PPEAF(M))RETURN
        NMSWPT(M)=NMSWPT(M)+1
        IOB(KT)=-1
        IPO=5HSWEPT
        CALL BOOM(IDET,1)
        RETURN
C
C       IF A DETONATION OCCURED, REMOVE MINE
C
  650 IF (KOUNT(M).LE.0) GO TO 658
      IF (IT.LE.1) GO TO 658
      IT=IT-1
      CALL IPACK
      IOB(KT)=IWORD
      RETURN
  658 NMDET(M)=NMDET(M)+1
      OBY = 99972.
      IF(ISYP.EQ.0)ISYP=1
      CALL BOOM(IDET,1)
      IPO=9HDETONATED
      IOB(KT)=-1
      IF(NTTTRP(N))710,659
  659 CONTINUE
C
C       PROB. OF A KILL
C
      DO 690 K=1,NTGO
      IF(TGTYNW(K).GT.99969 ) GO TO 690
      KI=K
      IF(K.NE.ISAVE) GO TO 660
      XFIX=XFIX1
      GO TO 670
  660 XFIX=0.
      IF(NDVT.GT.0) CALL DIVCHK
  670 DISTPD=(OBX-TGTXOL(K)-XFIX)**2+(OBYPRT-TGTYNW(K))**2
      N=NTGTYP(K)
      PK=PRKLO(N,NOBTP2)**2
      IF(DISTPD.GT.PK) GO TO 690
      DISTPD=SQRT(DISTPD)
      NTABLE=(N-1)*21+(NOBTP2-1)*3+2
      CALL TABINT(DISTPD,NTABLE)
      RN=RANF(DUMMY)
      IF(RN.GT.PRBITY) GO TO 690
      KI=K
      IF(NTTTMD(N).GT.0) CALL DIVSET
      TGTYNW(K)=TGTYNW(K)+100000.
      TMTOFR(K)=9990.
      TGTVSV=TGTVEL(K)
      TGTVEL(K)=0.
      IF(ISYP.EQ.1) ISYP=2
      IF(NTTTCS(N).GT.0) NSPLFT=NSPLFT-1
```

Figure 30. (Continued)

```
      LEFTIN = LEFTIN - 1
      NKILLT=NKILLT+1
      NKILL(N)=NKILL(N)+1
      IF(NDFA.LT.1) GO TO 690
      DO 680 J=1,NDFA
      CALL STINT(ISVIFA,K,J,IBIT,KDFTTN,2)
  680 CONTINUE
  690 CONTINUE
      IF(ISYMP(I).GT.0) CALL SYMDET
  700 RETURN
  710 KI=ISAVE
C
C   ROLLER/PLOW KILL SECTION
C
      NMSWPT(M)=NMSWPT(M)+1
      PK=PRKLO(N,NOBTP2)
      IF(DISTPD.GT.PK)RETURN
      NTABLE=(N-1)*21+(NOBTP2-1)*3+2
      CALL TABINT(DISTPD,NTABLE)
      RN=RANF(DUMMY)
      IF(RN.GT.PRBITY)RETURN
      TGTYNW(ISAVE)=TGTYNW(ISAVE)+100000.
      TMTOFR(ISAVE)=9990.
      TGTVSV=TGTVEL(ISAVE)
      TGTVEL(ISAVE)=0.
      NSPLFT=NSPLFT-1
      LEFTIN=LEFTIN-1
      NKILLT=NKILLT+1
      NKILL(N)=NKILL(N)+1
      IF(NDFA.LT.1)RETURN
      DO 720 J=1,NDFA
      CALL STINT(ISVIFA,ISAVE,J,IBIT,KDFTTN,2)
  720 CONTINUE
      RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE SYMDET
      COMMON ACEP(5.2).ADEP(20).AEI(5.5.4).AI(20).AIMPTX(50).AIMPTY(50).
     *ALNGLC.ANGIMP(10).AREL(5.2).AREP(20).AWIDLC.AYYVP(10).DBFAE.
     *DEFHT(5).DEFL(5).DEFRAD(5).DEFW(5).DEFX(20).DEFY(20).DELATM(100).
     *DEP(10).DFTFAE.DIRATK(10).DIRDIS(100).DMPIIX(10.10).DMPIIY(10.10).
     *DUDPRB(7).D3DEL.EI(5.5.2).ID.IDISOP.IDP(20.15.2).IEND.
     *IIS.IMINE.INDFA.INTIME(7).IOB(5000).IPO.IPRINT.IRNK(7).IRTFIR.
     *IRUNS.ISAVE.ISOL.ISVIFA(30).ISVLST.ISYMP(3).ISYP.IT.ITEROP.
     *ITGTPR(5.5).IVAP.IVEL.IWORD.IWTDEF(20).IWTVAP(10)
      COMMON JMARKI.JSELDS(7).KABOOM(547).KDFTTN(100).KNRS.KOUNT(7).
     *KTSAV(100).KI.LCFOPT.LCFTT.LDFDPR(5.5).LEFTIN.MADIV.MIFBT(7).
     *MODE.MTFA(50).MUSH.NAP.NCTAW(100).ND.NDEFEA(15.20).NDF.NDFA.
     *NDFAA.NDFDAM(5).NDFWD.NDFWT.NDVT.NGTAW(100).NGTAWT.NGTAWI(100).
     *NIDBT(5).NITBT(5).NKILL(5).NKILLD(5).NKILLI(5).NKILLT.NMDET(7).
     *NMIN(7).NMSWPT(7).NMT.NOB.NOBEVT.NOBTP2.NOIT.NOSTAT.NRAD(5).
     *NRADFD(20).NRADFI(100).NRAI(5).NRBA.NRFBDT(5).NRFBIT(5).
     *NRFIRD(100).NRS.NSPL T.NSTICK(50).NSUB(5).NTCOL(100).NTGO.NTGTP.
     *NTGTYP(100).NTLCIF(10).NTLOST.NTTTCS(5).NTTTMD(5).NTTTRP(5).NVAP.
     *NVFAEA(10).NVLIDF(10).NWEPV(10).OBX.OBY.OBYPRT.PATRAD(5).POLCF
      COMMON PHD(5.5).PPEAF(7).PRBITY.PROTNO(5.7).PRKLO(5.7).
     *PROBIL(840).PRSWDO(5.7).RADFAE.RANGPR(840).RELRND(5).RELSUB(5).
     *REP(10).RN.ROTDMPX(10.10).ROTDMPY(10.10).RSP(5).S(100).SECON(7).
     *SIGAD(50).SIGAR(50).SIGBD(50).SIGBR(50).STATAL(5.52).SWPDEL(100).
     *SYMDDF(5.7).SYMDIF(5.7).SYMDIS(7.7).SYMMAX(3).TARHT(5).TARL(5).
     *TARRAD(5).TARW(5).TDBIFV(10).TGTDEL(100).TGTOVL.TGTSPD.
     *TGTVEL(100).TGTVL2.TGTVSV.TGTXOL(100).TGTYNW(100).TGTYOL(100).
     *TGTYSV.THETA.THRSIG(5.5).TIMEMV(100).TMBRD(5).TMBRI(5).TMDLCF.
     *TMSWP(7).TMTOFR(130).TOTSIM.TRAVTM.XCYCLE(7).XDMP(10.10).XFIX.
     *XMAX.XMIN.XODEF(20).XOVP(10).
     *XRDFO(30).XROAD(11).XSWATH(50).XWIDTH.YDIV(100).YDMP(10.10).
     *YLENGTH.YODEF(20).YOVP(10).YRDFO(30).YROAD(11).YSWATH(50)
C****
      DIMENSION XSYM(2.100).YSYM(2.100).NOBT(100)
      KNOB=NOB-2
      I1=1
      I2=2
      IF(NOBTP2-16)300.310.320
  300 KTS=KTSAV(ISAVE)
      MINNUM=1
      ISUB=1
      KNOBT=NOBT(1)-NOBTP2
      SOBX=XSYM(1.1)-OBX
      SOBY=YSYM(1.1)-OBYPRT
      GO TO 10
  310 KTS=KTSAV(ISAVE)
      ISUB=3
      J=NWEPV(IMINE)
      DO 315 K=1.J
      XSYM(I1.K)=ROTDMPX(IMINE.K)
      YSYM(I1.K)=ROTDMPY(IMINE.K)
  315 NOBT(K)=16
      MINNUM=J
      GO TO 10
  320 KTS=KTSAV(IIS)
      ISUB=2
      MINNUM=1
      NOBT(1)=17
      XSYM(1.1)=TGTXOL(IIS)
      YSYM(1.1)=TGTYNW(IIS)
   10 NLST=MINNUM
      MINNUM=0
      YMAX=0.
      YMIN=99999.
      DO 20 I=1.NLST
      YMAX=AMAX1(YMAX.YSYM(I1.I))
   20 YMIN=AMIN1(YMIN.YSYM(I1.I))
      KTMIN=KTMAX=KTSI=KTS
   30 KTSI=KTSI-1
      IF(KTSI.LT.2) GO TO 40
      IF(IOB(KTSI).EQ.-1) GO TO 30
      IWORD=IOB(KTSI)
      CALL UNPACK
```

Figure 30. (Continued)

```
      IF(NOBTP2.GT.8) GO TO 30
      IF(YMIN-SYMMAX(ISUB).GT.OBY) GO TO 40
      KTMIN=KTSI
      GO TO 30
   40 KTSI=KTS
   50 KTSI=KTSI+1
      IF(KTSI.GT.KNOB) GO TO 60
      IF(IOB(KTSI).EQ.-1) GO TO 50
      IWORD=IOB(KTSI)
      CALL UNPACK
      IF(NOBTP2.GT.8) GO TO 50
      IF(YMAX+SYMMAX(ISUB).LT.OBY) GO TO 60
      KTMAX=KTSI
      GO TO 50
   60 DO 120 I=KTMIN,KTMAX
      IF(IOB(I).EQ.-1) GO TO 120
      IWORD=IOB(I)
      CALL UNPACK
      N=NOBTP2
      IF(NOBTP2.GT.8) GO TO 120
      DO 110 J=1,NLST
      DIS=(OBX-XSYM(I1,J))**2+(OBY-YSYM(I1,J))**2
      IF(NOBT(J)-16)390,400,410
  390 K=MOD(NOBT(J),8)
      IF(DIS.GT.SYMDIS(K,N)) GO TO 110
      GO TO 65
  400 K=IWTVAP(IMINE)
      IF(DIS.GT.SYMDIF(K,N)) GO TO 110
      GO TO 65
  410 K=IWTDEF(NDF)
      IF(DIS.GT.SYMDDF(K,N)) GO TO 110
   65 MINNUM=MINNUM+1
      NMDET(N)=NMDET(N)+1
      IF(MINNUM.LE.100) GO TO 70
      WRITE(6,1000)
 1000 FORMAT(1H0,'MORE THAN 100 SYMPATHETIC DETONATIONS')
      CALL EXIT
   70 XSYM(I2,MINNUM)=OBX
      YSYM(I2,MINNUM)=OBY
      NOBT(MINNUM)=NOBTP2
      CALL BOOM(IDET,I)
      IOB(I)=-1
      IF(IPRINT.NE.IRUNS) GO TO 120
      IF(MINNUM.EQ.1) WRITE(6,1010)
 1010 FORMAT(' SYMPATHETIC DETONATIONS  OB-NUM  OBS-TYPE   OB X   OB Y')
      WRITE(6,1020) I,NOBTP2,OBX,OBY
 1020 FORMAT(26X,I5,I10,F8.1,F7.1)
      GO TO 120
  110 CONTINUE
  120 CONTINUE
      IF(MINNUM.EQ.0) GO TO 200
      I3=I1
      I1=I2
      I2=I3
      ISUB=1
      GO TO 10
  200 NOBTP2=KNOBT
      OBX=SOBX
      OBYPRT=SOBY
      RETURN
      END                                                          0
```

Figure 30. (Continued)

```
      SUBROUTINE PRINTO
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUDPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTIN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LDFDPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NDVT,NGTAW(100),NGTAWT,NGTAWI(100),
     *NIOBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),PDLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PRDTNO(5,7),PRKLO(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C****
      TOTSIM=TIMEMV(ISAVE)+TGTDEL(ISAVE)+SWPDEL(ISAVE)
      IF(NOBTP2.EQ.17) GO TO 1520
      IF(NOBTP2.EQ.18) GO TO 1530
      IF(NOBTP2.EQ.16)RETURN
      IF(NOBTP2-8)10,1500
   10 DO 280 KI=1,11
      K6=KI*10
      K5=K6-9
      IF(K6.GT.NTGO) K6=NTGO
      PRINT 1001,(I,I=K5,K6)
      PRINT 1002,(KTSAV(I),I=K5,K6)
      PRINT 1003,(DIRDIS(I),I=K5,K6)
      IF(K6.EQ.NTGO) GO TO 40
  280 CONTINUE
 1001 FORMAT('0TARGET',2X,10I9)
 1002 FORMAT(' OBSTACLE',10I9)
 1003 FORMAT(' DISTANCE',10F9.2)
40    TYPRIT = TGTYNW(ISAVE)
      TVELPR=TGTVEL(ISAVE)
      IF(TGTYNW(ISAVE).LT.99970.) GO TO 1004
      TYPRIT=TGTYSV
      TVELPR=TGTVSV
 1004 WRITE(6,1400) ISAVE,NTGTYP(ISAVE),TYPRIT,TGTXOL(ISAVE),
     *TVELPR,TIMEMV(ISAVE),TOTSIM
      WRITE(6,1410)KTSAV(ISAVE),NOBTP2,OBX,OBYPRT,PRBITY,RN,IPO
      WRITE(6,1420)
      NOBEVT=NOBEVT+1
      IF(NOBEVT.GT.200) IPRINT=0
      N2=NTGO/2
      DO 1019 K=1,N2
      M=K+N2
      TOT2=DELATM(M)
      TOTDEL=DELATM(K)
 1019 WRITE(6,1120) K,NTGTYP(K),TGTYNW(K),TGTXOL(K),TGTVEL(K),TIMEMV(K),
     *TOTDEL,M,NTGTYP(M),TGTYNW(M),TGTXOL(M),TGTVEL(M),TIMEMV(M),
     *TOT2
      IF(M-NTGO)1440,1012
 1440 M=NTGO
      TOTDEL=DELATM(M)
      WRITE(6,1120)M,NTGTYP(M),TGTYNW(M),TGTXOL(M),TGTVEL(M),TIMEMV(M),
```

Figure 30. (Continued)

```
     *TOTDEL
1012 RETURN
1500 WRITE(6,1510)ISAVE,OBYPRT,TOTSIM
1510 FORMAT(1X,9(1H*),* TRAVEL PATH BOUNDARY  EVENT TOT =*
    8I4,*  OB Y=*,F8.1,*  BREACH TIME=*,F8.3,9(1H*))
     RETURN
1520 IPO=8HENTRANCE
     GO TO 1540
1530 IPO=4HEXIT
1540 WRITE(6,1545)IPO,IT,OBYPRT,ISAVE
1545 FORMAT(1X,9(1H*),* DIRECT FIRE AREA *,A10,
    8* NUMBER *,I3,*  OB Y=*,F8.1,*  EVENT TOT*,I5,9(1H*))
     RETURN
1120 FORMAT(1X,2(I3,I4,1X,F10.2,F9.2,F9.2,F11.2,F10.2,6X))
1400 FORMAT(1X/1X,10HEVENT TOT=,I4,2X,9HTGT TYPE=,I3,2X,6HTGT Y=,
    *F8.1,8H  TGT X=,F7.1/9H TGT VEL=,F6.1,2X,16HTOTAL TRAV TIME=,
    *F8.3,2X,12HBREACH TIME=,F8.3)
1410 FORMAT(1X/1X,10HEVENT OBS=,I4,2X,9HOBS TYPE=,I3,2X,5HOB X=,F8.1,
    *2X,5HOB Y=,F8.1,2X,5HPROB=,F5.2,2X,3HRN=,F5.2,5X,A10)
1420 FORMAT(1H0,2(8HTGT TYPE,5X,5HTGT Y,4X,5HTGT X,2X,7HTGT VEL,2X,
    *9HTRAV TIME,2X,8HDEL TIME,6X)/)
     END
```

Figure 30. (Continued)

```
      SUBROUTINE PRINTR
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPIX(50),AIMPIY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUDPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LDFDPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NDVT,NGTAW(100),NGTAWT,NGTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),PDLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PRDTNO(5,7),PRKLO(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
C....*YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
      COMMON /PD/ XRG(52),IRN,DIST(52)
      DIMENSION OUT(16)
      DO 60 I=1,52
   60 DIST(I)=0.00
      IF(JMARKI.LT.1) GO TO 80
      DO 70 J=1,52
70    XRG(J)=0.
      REWIND 7
      JMARKI=0
      IF(ITEROP.LT.1) GO TO 100
      NTMAX=MAX0(NMT,NTGTP,NDFWT)
80    IF(MOD(IRUNS,NOSTAT).NE.1) GO TO 100
      WRITE(6,5000) IEND,MODE,(NITBT(I),I=1,NTGTP)
      IF(NDFWT.GT.0) WRITE(6,5001)(NIDBT(I),I=1,NDFWT)
      IF(NMT.GT.0) WRITE(6,5002)(NMIN(I),I=1,NMT)
      IF(ITEROP.LT.1)GO TO 100
      WRITE(8,5003)
      WRITE(6,5004)
100   BIG=0.
      DO 110 I=1,NTGO
      SUM=TIMEMV(I)+TGTDEL(I)+SWPDEL(I)
      IF(SUM.LT.BIG) GO TO 110
      BIG=SUM
      TGTD=TGTDEL(I)
      SWPD=SWPDEL(I)
      TMMV=TIMEMV(I)
110   CONTINUE
      TOTSIM=BIG
      IF(ITEROP.LT.1) GO TO 310
      WRITE(6,2010)
120   DO 300 I=1,NTMAX
      DO 150 J=1,16
150   OUT(J)=1H
      IF(I.LT.2) ENCODE(5,1001,OUT(1)) IRUNS
      ENCODE(5,1001,OUT(2)) I
      IF(NTGTP.GE.I.AND.NMT.GT.0) ENCODE(6,1002,OUT(3)) NKILL(I)
      IF(NTGTP.GE.I.AND.NDFWT.GT.0) ENCODE(7,1004,OUT(4)) NKILLD(I)
      IF(NTGTP.GE.I.AND.NVAP.GT.0) ENCODE(7,1004,OUT(5)) NKILLI(I)
      IF(NDFWT.GE.I.AND.IRTFIR.GT.0) ENCODE(9,1006,OUT(6)) NDFDAM(I)
      IF(NTGTP.GE.I.AND.IRTFIR.GT.0) ENCODE(10,1007,OUT(7)) NRFBIT(I)
```

Figure 30. (Continued)

```
      IF(NDFWT.GE.1) ENCODE(8,1008,OUT(8)) NRFBDT(I)
      IF(I.GT.NMT) GO TO 180
      ENCODE(10,1007,OUT(9)) NMDET(I)
      ENCODE(10,1007,OUT(10)) MIFBT(I)
      ENCODE(8,1008,OUT(11)) NMSWPT(I)
180   IF(I.GT.1) GO TO 200
      IF(NGTAWT.GT.0) ENCODE(6,1002,OUT(12)) NTLOST
      IF(MADIV.GT.0) ENCODE(8,1013,OUT(13)) TGTD
      IF(MODE.GT.1) ENCODE(7,1014,OUT(14)) SWPD
      ENCODE(8,1013,OUT(15)) TMMV
      ENCODE(8,1013,OUT(16)) TOTSIM
200   N=11
      IF(I.LT.2) N=16
      WRITE(6,2000) (OUT(K),K=1,N)
300   CONTINUE
3.0   DO 320 I=1,NTGTP
      DIST(I)=NKILL(I)
      DIST(I+5)=NKILLD(I)
      DIST(I+10)=NKILLI(I)
320   DIST(I+20)=NRFBIT(I)
      DO 330 I=1,NDFWT
      DIST(I+15)=NDFDAM(I)
330   DIST(I+25)=NRFBDT(I)
      DO 340 I=1,NMT
      DIST(I+30)=NMDET(I)
      DIST(I+37)=MIFBT(I)
340   DIST(I+44)=NMSWPT(I)
      DIST(52)=TOTSIM
      IF(IDISOP.LT.1) GO TO 360
      DO 350 I=1,52
350   XRG(I)=AMAX1(XRG(I),DIST(I))
      WRITE(7) DIST
360   DO 370 I=1,52
      STATAL(1,I)=STATAL(1,I)+DIST(I)
370   STATAL(2,I)=STATAL(2,I)+DIST(I)**2
      IF(MOD(IRUNS,NOSTAT).NE.0) RETURN
      RUNS=IRUNS
      IRN=IRUNS
      DO 380 I=1,52
      STATAL(3,I)=STATAL(1,I)/RUNS
      STATAL(4,I)=(STATAL(2,I)-(STATAL(1,I)**2)/RUNS)/(RUNS-1.0)
      IF(STATAL(4,I).GT.0.) STATAL(5,I)=SQRT(STATAL(4,I))
380   CONTINUE
      WRITE(6,6000)
      IF(NMT.GT.0) WRITE(6,6010)((STATAL(I,J),I=3,5),J=1,NTGTP)
      K=NTGTP+5
      IF(NDFWT.GT.0) WRITE(6,6020)((STATAL(I,J),I=3,5),J=6,K)
      K=NTGTP+10
      IF(NVAP.GT.0) WRITE(6,6030)((STATAL(I,J),I=3,5),J=11,K)
      K=NDFWT+15
      IF(NDFWT.GT.0) WRITE(6,6040)((STATAL(I,J),I=3,5),J=16,K)
      K=NTGTP+20
      IF(NDFWT.GT.0) WRITE(6,6050)
      IF(IRTFIR.GT.0) WRITE(6,6060)((STATAL(I,J),I=3,5),J=21,K)
      K=NDFWT+25
      IF(NDFWT.GT.0) WRITE(6,6070)((STATAL(I,J),I=3,5),J=26,K)
      K=NMT+30
      IF(NMT.LT.1) GO TO 400
      WRITE(6,6080)((STATAL(I,J),I=3,5),J=31,K)
      K=NMT+37
      WRITE(6,6090)((STATAL(I,J),I=3,5),J=38,K)
      K=NMT+44
      IF(MODE.EQ.3) WRITE(6,6100)((STATAL(I,J),I=3,5),J=45,K)
400   WRITE(6,6110)(STATAL(I,52),I=3,5)
      IF(IDISOP.GT.0) CALL DISTR(NMT,NTGTP,NDFWT)
      RETURN
5000  FORMAT(1H1,40X,*RUN NUMBER *,I3,*    TACTIC NUMBER *,I3/
     *35X,*INITIAL NUMBER OF INTRUDERS BY TYPE *,5I6)
5001  FORMAT(35X,*INITIAL NUMBER OF DEFENDERS BY TYPE *,5I6)
5002  FORMAT(35X,*NUMBER OF MINES DISPENSED BY TYPE    *,7I6)
5003  FORMAT(1H0,12X,*INTRUDERS DAMAGED BY*/2X,*ITER*,16X,
     **DIR     IND.  DEFENDERS  ROUNDS FIRED BY     MINES       *,
```

Figure 30. (Continued)

```
      **MINES   MINES  TGTS   RMVL  SWEEP  TRAVEL  BREACH*/
      *2X,*NUM.  TYPE  MINES   FIRE    FIRE    DAMAGED       INT.*
      **     DEF     DETONATED  IN FIELD  SWEPT  LOST    TIME    TIME*
      **    TIME     TIME*)
5004  FORMAT(2(2X,4H****),3(2X,5H*****),2X,3(3H***),1X,
      *2(2X,6H******),2X,3(3H***),2X,4(2H**),2X,5H*****,2X,4H****,
      *2(2X,5H*****),2(2X,6H******))
1001  FORMAT(I5)
1002  FORMAT(I6)
1004  FORMAT(I7)
1006  FORMAT(I9)
1007  FORMAT(I10)
1008  FORMAT(I8)
1013  FORMAT(F8.1)
1014  FORMAT(F7.1)
2000  FORMAT(1X,2A5,A6,2A7,1X,A9,A10,A8,2A10,1X,A8,A6,A8,A7,2A8)
 2010 FORMAT(1X)
6000  FORMAT(1H1,*STATISTICAL SUMMARY*,21X,*MEAN*,6X,*VARIANCE*,
     *5X,*STD. DEV.*//* INTRUDERS DAMAGED*)
6010  FORMAT(1H0,14X,*BY MINES*,8X,3F14.3/(31X,3F14.3))
6020  FORMAT(1H0,14X,*BY DIRECT FIRE  *,3F14.3/(31X,3F14.3))
6030  FORMAT(1H0,14X,*BY INDIRECT FIRE*,3F14.3/(31X,3F14.3))
6040  FORMAT(1H0,*DEFENDERS DAMAGED*,13X,3F14.3/(31X,3F14.3))
6050  FORMAT(1H0,*ROUNDS FIRED*)
6060  FORMAT(1H0,9X,*BY INTRUDERS*,9X,3F14.3/(31X,3F14.3))
6070  FORMAT(1H0,9X,*BY DEFENDERS*,9X,3F14.3/(31X,3F14.3))
6080  FORMAT(1H0,*MINES DETONATED*,15X,3F14.3/(31X,3F14.3))
6090  FORMAT(1H0,*MINES IN FIELD*,16X,3F14.3/(31X,3F14.3))
6100  FORMAT(1H0,*MINES SWEPT*,19X,3F14.3/(31X,3F14.3))
6110  FORMAT(1H0,*BREACH TIME (MINUTES)*,9X,3F14.3)
      END
```

Figure 30. (Continued)

```
      SUBROUTINE DISTR(NMT,NTGTP,NDFWT)
      COMMON /PD/  XRG(52),IRN,DIST(52)
      DIMENSION DIST5(21,52),INT(52),NFMT(27),KFMT(27),IFMT(27),JFMT(27)
      DIMENSION IOUT(15),OUT(21,15),LFMT(27),MFMT(27)
      DATA IFMT/10H(1X,8HINTE,5HRVAL,,3HA7,,3HA7,,3HA7,,3HA7,,
     *3HA7,,3H3X,,3HA7,,3HA7,,3HA7,,3HA7,,3HA7,,3H3X,,
     *3HA7,,3HA7,,3HA7,,3HA7,,3HA7,,3H3X ,1H),6*(1H )/
      DATA JFMT/10H(2X,5HCLAS,10HS/(3X12,6X,3HR7,,3HR7,,3HR7,,
     *3HR7,,3HR7,,3H3X,,3HR7,,3HR7,,3HR7,,3HR7,,3HR7,,3H3X,,
     *3HR7,,3HR7,,3HR7,,3HR7,,3HR7,,3H3X),1H),6*(1H )/
      DATA NFMT/10H(1X,8HINTE,5HRVAL,,3HA7,,3HA7,,3HA7,,3HA7,,
     *3HA7,,3HA7,,3HA7,,3H3X,,3HA7,,3HA7,,3HA7,,3HA7,,3HA7,,
     *3HA7,,3HA7,,3H3X ,1H),8*(1H )/
      DATA KFMT/10H(2X,5HCLAS,10HS/(3X12,6X,3HR7,,3HR7,,3HR7,,
     *3HR7,,3HR7,,3HR7,,3HR7,,3H3X,,3HR7,,3HR7,,3HR7,,3HR7,,
     *3HR7,,3HR7,,3HR7,,3H3X),1H),8*(1H )/
      XRN=1.0/FLOAT(IRN)
      DO 20 I=1,52
      INT(I)=IFIX(XRG(I))/20+1
      IF(INT(I).LT.11) GO TO 10
      L=ALOG10(FLOAT(INT(I)))
      L1=10*L
      INT(I)=(INT(I)/L1+1)*L1
   10 DO 20 K=1,21
   20 DIST5(K,I)=0.0
      REWIND 7
C
C
      DO 50 I=1,IRN
      READ(7)DIST
      DO 50 J=1,52
      K1=(DIST(J)-.01)/FLOAT(INT(J))+2.0
      IF(DIST(J).EQ.0.0)K1=1
   50 DIST5(K1,J)=DIST5(K1,J)+XRN
      KZ=0
      WRITE(6,1000)
 1000 FORMAT(1H1,50X,34HD I S T R I B U T I O N S   F O R.
     *//)
      WRITE(6,1001)
 1001 FORMAT(9X,36(1H*),*I N T R U D E R S  D A M A G E D  B Y*,
     *39(1H*),/,9X,1H*,13X,9HM I N E S,12X,4H*   *,6X,
     *20HD I R E C T  F I R E,8X,4H*   *,4X,24HI N D I R E C T  F I R E,
     *6X,1H*)
      WRITE(6,1007)
 1007 FORMAT(9X,3(36(1H*),2X))
      DO 85 I=1,27
      LFMT(I)=IFMT(I)
      MFMT(I)=JFMT(I)
   85 CONTINUE
      DO 90 I=1,15
      IOUT(I)=1H
      DO 90 J=1,21
      OUT(J,I)=1H
   90 CONTINUE
      IF(NMT.LT.1) GO TO 110
      DO 100 I=1,NTGTP
      IOUT(I)=INT(I)
      LFMT(I+2)=3HI7,
      MFMT(I+2)=5HF7.3,
   94 DO 95 J=1,21
      OUT(J,I)=DIST5(J,I)
   95 CONTINUE
  100 CONTINUE
  110 IF(NDFWT.LT.1) GO TO 180
      DO 150 I=1,NTGTP
      I8=I+8
      IOUT(I+5)=INT(I+5)
      LFMT(I8)=3HI7,
      MFMT(I8)=5HF7.3,
  144 DO 145 J=1,21
      OUT(J,I+5)=DIST5(J,I+5)
  145 CONTINUE
```

Figure 30. (Continued)

```
 150 CONTINUE
 180 IF(NDFWT.LT.1) GO TO 200
      DO 195 I=1,NTGTP
      I14=I+14
      IOUT(I+10)=INT(I+10)
      LFMT(I14)=3HI7,
      MFMT(I14)=5HF7.3,
 189  DO 190 J=1,21
      OUT(J,I+10)=DISTS(J,I+10)
 190  CONTINUE
 195  CONTINUE
 200  WRITE(6,LFMT)IOUT
      WRITE(6,MFMT)(I,(OUT(I+1,J),J=1,15),I=KZ,20)
      IF(NDFWT.LT.1) GO TO 500
C
C
      DO 210 I=1,15
      IOUT(I)=1H
      DO 210 J=1,21
      OUT(J,I)=1H
 210  CONTINUE
      DO 215 I=1,27
      LFMT(I)=IFMT(I)
      MFMT(I)=JFMT(I)
 215  CONTINUE
      WRITE(6,1002)
1002  FORMAT(////,9X,112(1H*),/,
     *9X,1H*,34X,4H*  *,22X,'R O U N D S  F I R E D',
     1'  B Y',23X,1H*,/,9X,39H* D E F E N D E R S  D A M A G E D *  *,
     28X,17HI N T R U D E R S,9X,4H*  *,9X,'D E F E N D E R S'
     3,8X,1H*)
      WRITE(6,1007)
      DO 250 I=1,NDFWT
      IOUT(I)=INT(I+15)
      LFMT(I+2)=3HI7,
      MFMT(I+2)=5HF7.3,
      DO 240 J=1,21
      OUT(J,I)=DISTS(J,I+15)
 240  CONTINUE
 250  CONTINUE
      DO 285 I=1,NTGTP
      IOUT(I+5)=INT(I+20)
      LFMT(I+8)=3HI7,
      MFMT(I+8)=5HF7.3,
      DO 280 J=1,21
      OUT(J,I+5)=DISTS(J,I+20)
 280  CONTINUE
 285  CONTINUE
      DO 300 I=1,NDFWT
      IOUT(I+10)=INT(I+25)
      LFMT(I+14)=3HI7,
      MFMT(I+14)=5HF7.3,
      DO 295 J=1,21
      OUT(J,I+10)=DISTS(J,I+25)
 295  CONTINUE
 300  CONTINUE
      WRITE(6,LFMT)IOUT
      WRITE(6,MFMT)(I,(OUT(I+1,J),J=1,15),I=KZ,20)
      WRITE(6,1003)
1003  FORMAT(////)
 500  WRITE(6,1000)
      IF(NMT.LT.1) GO TO 700
1005  FORMAT(9X,1H*,10X,28HM I N E S  D E T O N A T E D,9X
     1,4H*  *,10X,25HM I N E S  I N  F I E L D,12X,1H*)
1006  FORMAT(9X,1H*,13X,20HM I N E S  S W E P T,14X,4H*  *,
     113X,20HB R E A C H  T I M E,14X,1H*)
      DO 510 I=1,27
      LFMT(I)=NFMT(I)
 510  MFMT(I)=KFMT(I)
      DO 520 I=1,15
      IOUT(I)=1H
      DO 520 J=1,21
```

Figure 30. (Continued)

```
      OUT(J,I)=1H
  520 CONTINUE
      WRITE(6,1008)
      WRITE(6,1005)
      WRITE(6,1008)
C
      DO 550 I=1,NMT
      IOUT(I)=INT(I+30)
      LFMT(I+2)=3HI7,
      MFMT(I+2)=5HF7.3,
      DO 540 J=1,21
      OUT(J,I)=DISTS(J,I+30)
  540 CONTINUE
  550 CONTINUE
      DO 570 I=1,NMT
      IOUT(I+7)=INT(I+37)
      LFMT(I+10)=2HI7
      MFMT(I+10)=4HF7.3
      DO 560 J=1,21
      OUT(J,I+7)=DISTS(J,I+37)
  560 CONTINUE
  570 CONTINUE
      WRITE(6,LFMT) (IOUT(I),I=1,14)
      WRITE(6,MFMT)(I,(OUT(I+1,J),J=1,14),I=KZ,20)
 1008 FORMAT(9X,49(1H*),2X,49(1H*))
      WRITE(6,1003)
  700 DO 710 I=1,27
      LFMT(I)=NFMT(I)
      MFMT(I)=KFMT(I)
  710 CONTINUE
      LFMT(13)=3HI7,
      MFMT(13)=5HF7.3,
      DO 720 I=1,15
      IOUT(I)=1H
      DO 720 J=1,21
      OUT(J,I)=1H
  720 CONTINUE
      DO 780 I=1,NMT
      IOUT(I)=INT(I+44)
      LFMT(I+2)=3HI7,
      MFMT(I+2)=5HF7.3,
      DO 770 J=1,21
      OUT(J,I)=DISTS(J,I+44)
  770 CONTINUE
  780 CONTINUE
      IOUT(10)=INT(52)
      DO 790 J=1,21
      OUT(J,10)=DISTS(J,52)
  790 CONTINUE
      WRITE(6,1008)
      WRITE(6,1006)
      WRITE(6,1008)
      WRITE(6,LFMT)(IOUT(I),I=1,14)
      WRITE(6,MFMT)(I,(OUT(I+1,J),J=1,14),I=KZ,20)
      RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE TABINT(DISTPD,NTABLE)
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AVYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUDPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LDFDPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NDVT,NGTAW(100),NGTAWT,NGTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),PDLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PRDTNO(5,7),PRKLO(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(400),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C....
 10   NB=NTABLE*8-7
      NE=NB+7
      DO 50 K5=NB,NE
      IF (DISTPD.GE.RANGPR(K5).AND.DISTPD.LE. RANGPR(K5+1)) GO TO 55
 50   CONTINUE
      GO TO 60
 55   PRBITY=PROBIL(K5)+ (DISTPD-RANGPR(K5))/ (RANGPR(K5+1) - RANGPR(K5)
     2    )* (PROBIL(K5+1)-PROBIL(K5))
      GO TO 70
 60   PRBITY=0.
 70   RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE RNORM(RSTART)
      RN19 = RANF(DUMMY)
      Q = ABS(1.-2.0*RN19)
      Q = .5*(1.0-Q)
      Q = -2.*ALOG(Q)
      V = SQRT(Q)
      SIGN = 1.
      IF(RN19-.5) 10,10,20
   10 SIGN=-1.
   20 Q=2.515517+.802853*V+.010328*V*V
      QQ = 1.+1.432788*V+.189259*V*V+.0013208*V*V*V
      RSTART=(V-Q/QQ)*SIGN
      RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE IPACK
C
C     THIS SUBROUTINE PACKS THE MINE INFORMATION INTO IWORD
C
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUDPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTS  (100),KI,LCFOPT,LCFTT,LDFDPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NDVT,NGTAW(100),NGIAWT,NGTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOII,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGIP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),PDLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PRDTNO(5,7),PRKLO(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C....
      IX = OBX * 10.0
      IY = OBY * 10.0
      IWORD = 0
      IWORD=IWORD.OR.IMINE
      IWORD=IWORD.OR.SHIFT(NOBTP2,15)
      IWORD=IWORD.OR.SHIFT(IT,20)
      IWORD=IWORD.OR.SHIFT(IABS(IX),28)
      IF(IX.LT.0) IWORD=IWORD.OR.10000000000000B
      IWORD=IWORD.OR.SHIFT(IY,43)
      RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE UNPACK
C
C     THIS SUBROUTINE UNPACKS THE MINE INFORMATION FROM IWORD
C
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPIX(50),AIMPIY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIX(10,10),DMPIY(10,10),
     *DUDPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LDFDPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NDVT,NGTAW(100),NGTAWT,NGTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBUT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),PDLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PROTNO(5,7),PRKLO(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTOMPX(10,10),ROTOMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIO(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C*****
      OBY=FLOAT(SHIFT(IWORD,-43).AND.177777B)/10.
      OBX=FLOAT(SHIFT(IWORD,-28).AND.37777B)/10.
      ITEMP=IWORD.AND.1000000000000000B
      IF(ITEMP.NE.0) OBX=-OBX
      NOBTP2=SHIFT(IWORD,-15).AND.37B
      IMINE=IWORD.AND.77777B
   10 IT= SHIFT(IWORD,-20).AND.377B
   20 RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE NDFIRE
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUDPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LDFDPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NDVT,NGTAW(100),NGTAWT,NOTAWI(100),
     *NIOBT(5),NITBT(5),NKILL(5),NKILLO(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFO(20),NRADFI(100),NRAI(5),NRBA,NRFBOT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),POLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PRDTNO(5,7),PRKLD(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C....
      BIGG(X)=.5*SQRT(1.-EXP(-.63*X**2))
      PI=3.141592654
      SRPI=SQRT(PI)
      IWT=IWTVAP(IVAP)
      ICMHE=1
      IF(NSUB(IWT).LT.1) ICMHE=2
      COSIMP=COS(ANGIMP(IVAP)*.01745329258)
      SINIMP=SIN(ANGIMP(IVAP)*.01745329258)
      ANG=DIRATK(IVAP)
      COSANG=COS(ANG)
      SINANG=SIN(ANG)
      NW=NWEPV(IVAP)
      IF(IRUNS.NE.IPRINT)GO TO 90
      NVOL=NVFAEA(IVAP)-NVLIDF(IVAP)+1
      WRITE(6,1000)IVAP,NVOL,IWT
 1000 FORMAT(1X,* AIM POINT NO.*,I4,* VOLLEY NO.*,I4
     *,* INDIRECT FIRE WEAPON TYPE *,I3)
   90 CONTINUE
      DO 500 I=1,NTGO
      IF(TGTYNW(I).GT.99990.) GO TO 500
      XT=TGTXOL(I)
      YT=TGTYNW(I)
      ITT=NTGTYP(I)
      SURVPR=1.
      DO 480 J=1,NW
      EIVAL=EI(IWT,ITT,2)
      KODEI=EI(IWT,ITT,1)
      XW=ROTDMPX(IVAP,J)
      YW=ROTDMPY(IVAP,J)
      RO=ABS((XW-XT)*SINANG+(YW-YT)*COSANG)
      DO=ABS(-(XW-XT)*COSANG+(YW-YT)*SINANG)
      DSQ=RO**2+DO**2
      IF(DSQ.GT.THRSIG(IWT,ITT)) GO TO 480
      APHD=PHD(IWT,ITT)
      IF(ICMHE.GT.1) GO TO 110
      POWER=-(NSUB(IWT)*RELSUB(IWT)*EIVAL)/(PI*PATRAD(IWT)**2)
      IF(POWER.GT.-227.) GO TO 100
      APHD=1.
      GO TO 105
  100 APHD=1.-EXP(POWER)
```

Figure 30. (Continued)

```
 105 ETL=ETH=SRPI*PATRAD(IWT)
 110 GO TO (120,140,150,160),KODE
 120 IF(ICMHE.LT.2) GO TO 130
     ALWRAT=1.-.8*COSIMP
     ETL=2.*SQRT(EIVAL*ALWRAT/PI)
     ETH=ETL/ALWRAT
 130 DENOM=17.6*REP(IVAP)**2+ETL**2
     RSSP=ETL/SQRT(DENOM)*EXP((-4.*RO**2)/DENOM)
     DENOM=17.6*DEP(IVAP)**2+ETH**2
     DSSP=ETH/SQRT(DENOM)*EXP((-4.*DO**2)/DENOM)
 135 PKK=RSSP*DSSP*RELRND(IWT)*APHD
     GO TO 450
 140 ETH=SQRT(EIVAL)
     ETL=ETH/SINIMP
     GO TO 220
 150 ETL=ETH=SQRT(EIVAL)
     GO TO 220
 160 IF(TARRAD(ITT))170,180
 170 ETL=ETH=SRPI*(TARRAD(ITT)+EIVAL)
     GO TO 190
 180 ETL=TARL(ITT)+2.*EIVAL
     ETH=TARW(ITT)+2.*EIVAL
 190 IF(TARHT(ITT))200,220
 200 SHADOL=TARHT(ITT)*SINIMP/COSIMP
     IF(SHADOL.LT.EIVAL) GO TO 220
     IF(TARRAD(ITT))205,210
 205 ETL=(ETL**2+2.*TARRAD(ITT)*(SHADOL-EIVAL))/ETL
     GO TO 220
 210 ETL=(ETL*ETH+TARW(ITT)*(SHADOL-EIVAL))/ETH
 220 A1=(ETL+2.*RO)/(2.96*REP(IVAP))
     A2=ABS(ETL-2.*RO)/(2.96*REP(IVAP))
     B1=(ETH+2.*DO)/(2.96*DEP(IVAP))
     B2=ABS(ETH-2.*DO)/(2.96*DEP(IVAP))
     RSSP=BIGG(A1)+SIGN(1.,ETL-2.*RO)*BIGG(A2)
     DSSP=BIGG(B1)+SIGN(1.,ETH-2.*DO)*BIGG(B2)
     GO TO 135
 450 SURVPR=SURVPR*(1.-PKK)
 480 CONTINUE
     IF(SURVPR.EQ.1.) GO TO 500
     PDAM=1.-SURVPR
     RN=RANF(DUMMY)
     IF(RN.GT.PDAM) GO TO 490
     IF(IRUNS.NE.IPRINT) GO TO 485
     WRITE(6,1001)I,XT,YT,PDAM
1001 FORMAT(*  INTRUDER NO. *,I3,* TGT X *,F8.1,* TGT Y *,F8.1,
    ** PDAM *,F14.3,*      HIT HIM    *)
 485 TGTYNW(I)=TGTYNW(I)+100000.
     TGTYSV=TGTVEL(I)
     TMTOFR(I)=9990.
     TGTVEL(I)=0.
     LEFTIN=LEFTIN-1
     IF(NTTTCS(I).GT.0)NSPLFT=NSPLFT-1
     NKILLT=NKILLT+1
     NKILLI(ITT)=NKILLI(ITT)+1
     IF(NDFA.LT.1)GO TO 500
     DO 487 L=1,NDFA
 487 CALL STINT(ISVIFA,I,L,IBIT,KDFTIN,2)
     GO TO 500
 490 IF(IRUNS.EQ.IPRINT)WRITE(6,1002)I,XT,YT,PDAM
1002 FORMAT(*  INTRUDER NO. *,I3,* TGT X *,F8.1,* TGT Y *,F8.1,
    ** PDAM *,F14.3,*      MISSED    *)
 500 CONTINUE
     RETURN
     END
```

Figure 30. (Continued)

```
      SUBROUTINE DIRFIR(IDAM)
      COMMON ACEP(5.2).ADEP(20).AEI(5.5.4).AI(20).AIMPTX(50).AIMPTY(50)
     *ALNGLC.ANGIMP(10).AREL(5.2).AREP(20).AWIDLC.AYYVP(10).DBFAE.
     *DEFHT(5).DEFL(5).DEFRAD(5).DEFW(5).DEFX(20).DEFY(20).DELATM(100).
     *DEP(10).DFTFAE.DIRATK(10).DIRDIS(100).DMPIIX(10.10).DMPIIY(10.10).
     *DUDPRB(7).D3DEL.EI(5.5.2).ID.IDISOP.IDP(20.15.2).IEND.
     *IIS.IMINE.INDFA.INTIME(7).IOB(5000).IPO.IPRINT.IRNK(7).IRTFIR.
     *IRUNS.ISAVE.ISBL.ISVIFA(30).ISVLST.ISYMP(3).ISYP.IT.ITEROP.
     *ITGTPR(5.5).IVAP.IVEL.IWORD.IWTDEF(20).IWTVAP(10)
      COMMON JMARKI.JSELDS(7).KABOOM(547).KDFTTN(100).KNRS.KOUNT(7).
     *KTSAV(100).KI.LCFOPT.LCFTT.LDFDPR(5.5).LEFTIN.MADIV.MIFBT(7).
     *MODE.MTFA(50).MUSH.NAP.NCTAW(100).ND.NDEFEA(15.20).NDF.NDFA.
     *NDFAA.NDFDAM(5).NDFWD.NDFWT.NDVT.NGTAW(100).NGTAWT.NGTAWI(100).
     *NIDBT(5).NITBT(5).NKILL(5).NKILLD(5).NKILLI(5).NKILLT.NMDET(7).
     *NMIN(7).NMSHPT(7).NMT.NOB.NOBEVT.NOBTP2.NOIT.NOSTAT.NRAD(5).
     *NRADFD(20).NRADFI(100).NRAI(5).NRBA.NRFBDT(5).NRFBIT(5).
     *NRFIRD(130).NRS.NSPLFT.NSTICK(50).NSUB(5).NTCOL(100).NTGO.NTGIP.
     *NTGTYP(100).NTLCIF(10).NTLOST.NTTICS(5).NTTTMD(5).NTTTRP(5).NVAP.
     *NVFAEA(10).NVLIDF(10).NWEPV(10).OBX.OBY.OBYPRT.PATRAD(5).PDLCF
      COMMON PHD(5.5).PPEAF(7).PRBITY.PROTNO(5.7).PRKLO(5.7).
     *PROBIL(840).PRSWDO(5.7).RADFAE.RANGPR(840).RELRND(5).RELSUB(5).
     *REP(10).RN.ROTDMPX(10.10).ROTDMPY(10.10).RSP(5).S(100).SECON(7).
     *SIGAD(50).SIGAR(50).SIGBD(50).SIGBR(50).STATAL(5.52).SWPDEL(100)
     *SYMDDF(5.7).SYMDIF(5.7).SYMDIS(7.7).SYMMAX(3).TARHT(5).TARL(5).
     *TARRAD(5).TARW(5).TDBIFV(10).TGTDEL(100).TGTOVL.TGTSPD.
     *TGTVEL(100).TGTVL2.TGTVSV.TGTXOL(100).TGTYNW(100).TGTYOL(100).
     *TGTYSV.THETA.THRSIG(5.5).TIMEMV(100).TMBRD(5).TMBRI(5).TMDLCF.
     *TMSHP(7).TMTOFR(130).TOTSIM.TRAVTM.XCYCLE(7).XDMP(10.10).XFIX.
     *XMAX.XMIN.XODEF(20).XOVP(10).
     *XRDFO(30).XROAD(11).XSWATH(50).XWIDTH.YDIV(100).YDMP(10.10).
C....*YLENGTH.YODEF(20).YOVP(10).YRDFO(30).YROAD(11).YSWATH(50)
      BIGG(X)=.5*SQRT(1.-EXP(-.63*X**2))
      ID=IDAM
      IDAM=0
      ITT=NTGTYP(IIS)
      IWT=IWTDEF(NDF)
      L=IWT
      IF(ID.GT.1) L=ITT
      BREL=AREL(L.ID)
      BCEP=ACEP(L.ID)
      KODEI=AEI(IWT.ITT.2*ID-1)
      EIVAL=AEI(IWT.ITT.2*ID)
      IF(KODEI.GT.1) GO TO 50
      IND=IDP(NDF.KI.ID)
      ALWRAT=1.-.8*AI(IND)
      ETL=2.*SQRT(EIVAL*ALWRAT/3.141592654)
      ETW=ETL/ALWRAT
      DENOM=17.6*AREP(IND)**2+ETL**2
      RSSP=ETL/SQRT(DENOM)
      DENOM=17.6*ADEP(IND)**2+ETW**2
      DSSP=ETW/SQRT(DENOM)
      SSPD=RSSP*DSSP*BREL
      GO TO 100
   50 IF(BCEP.GT.0.) GO TO 60
      XD=(TGTXOL(IIS)-DEFX(NDF))**2
      YD=(TGTYNW(IIS)-DEFY(NDF))**2
      RNG=SQRT(XD+YD)
      BCEP=.001*RNG*ABS(BCEP)
   60 DENOM=1.7*BCEP
      IF(ID.GT.1) GO TO 70
      VERT=TARHT(ITT)
      HORIZ=2.*TARRAD(ITT)
      IF(HORIZ.LT..01) HORIZ=(TARL(ITT)+TARW(ITT))/2.
      GO TO 80
   70 VERT=DEFHT(IWT)
      HORIZ=2.*DEFRAD(IWT)
      IF(HORIZ.LT..01) HORIZ=(DEFL(IWT)+DEFW(IWT))/2
   80 AI=HORIZ/DENOM
      BI=VERT/DENOM
      RSSP=2.*BIGG(AI)
      DSSP=2.*BIGG(BI)
```

Figure 30. (Continued)

```
      SSPD=RSSP*DSSP*BREL*EIVAL
100   RN=RANF(DUMMY)
      IF(RN.LT.SSPD) IDAM=1
      PRBITY=SSPD
      RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE CKEVTM
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUDPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LOFOPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NOVT,NGTAW(100),NGTAWT,NGTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSHPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFO(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),N7LOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),POLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PRDTNO(5,7),PRKLD(5,7),
     *PROBIL(840),PRSWDD(5,7),RADFAE,RANOPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C*****
      DIMENSION TM(130),IPOS(130)
      IF(NDFA.GT.0) GOTO 50
      IF(INDFA.GT.0) GO TO 50
      IF(NOBTP2.LT.16.OR.NOBTP2.GT.18) GO TO 20
      IF(NOBTP2.GT.16) GO TO 15
      INDFA=1
      GO TO 20
C
C  SAVE THIS INTRUDER FOR THIS AREA BY TURNING ON A BIT IN ISVIFA
C
   15 CALL STINT(ISVIFA,ISAVE,IT,IBIT,KDFTTN,1)
      NDFA=MAX0(IT,NDFA)
      CALL TGTMOV
   16 DO 18 J=1,NDFWD
      IF(NDEFEA(IT,J).LT.1) GO TO 18
      NDF=NDEFEA(IT,J)+100
      IF(TMTOFR(NDF).GT.0.0.AND.TMTOFR(NDF).LT.9000.) GO TO 18
      TMTOFR(NDF)=0.
   18 CONTINUE
      RETURN
   20 CALL TGTMOV
      RETURN
   50 DO 60 I=1,130
      IPOS(I)=I
      TM(I)=TMTOFR(I)
   60 CONTINUE
      DO 100 I=1,130
      DO 90 J=1,130
      IF(TM(I)-TM(J))90,90,85
   85 KEEP=IPOS(I)
      IPOS(I)=IPOS(J)
      IPOS(J)=KEEP
      SAVE=TM(I)
      TM(I)=TM(J)
      TM(J)=SAVE
   90 CONTINUE
      IF(TM(I).GT.TRAVTM) GO TO 120
  100 CONTINUE
  120 NUMCNT=MIN0(I,130)
      IF(NUMCNT.GT.1) GO TO 150
```

Figure 30. (Continued)

```
      CALL TGTMOV
      IF(NOBTP2.NE.17) RETURN
      CALL STINT(ISVIFA,ISAVE,IT,IBIT,KDFTTN,1
      NDFA=MAXO(IT,NDFA)
      GO TO 16
C
C
  150 NUM=NUMCNT-1
      ISHOT=0
      DO 1000 MI=1,NUM
      M=IPOS(MI)
      TTDI=TMTOFR(M)
      IF(TTDI.GT.9000.) GO TO 1000
      TT=TRAVTM
      TRAVTM=TTDI
      CALL TGTMOV
      TRAVTM=TT-TTDI
      IF(M.GT.120) GO TO 750
      IF(M.LT.101) GO TO 500
C
C  THIS IS A DEFENDER FIRING AT AN INTRUDER
C
      NDF=M-100
      IF(NRADFD(NDF).LT.1) GO TO 900
      NDTYP=IWTDEF(NDF)
      DO 300 I=1,5
      IPRR=ITGTPR(NDTYP,I)
      IF(IPRR.LT.1) GO TO 1000
      DO 280 IIS=1,NTGO
      IF(NTGTYP(IIS).NE.IPRR) GO TO 280
      DO 270 K=1,NDFA
      CALL STINT(ISVIFA,IIS,K,IBIT,KDFTTN,3)
      IF(IBIT.LT.1) GOTO 270
      IF(NDEFEA(K,NDF).LT.1) GO TO 270
      GO TO 320
  270 CONTINUE
  280 CONTINUE
  300 CONTINUE
      GO TO 1000
  320 TMTOFR(M)=TMBRD(NDTYP)
      KI=K
      IDAM=1
      ISHOT=1
      CALL DIRFIR(IDAM)
      IF(ISYMP(2).GT.0) CALL SYMDET
      NRADFD(NDF)=NRADFD(NDF)-1
      IF(NRADFD(NDF).LT.1) TMTOFR(M)=9991.
      NRFBDT(NDTYP)=NRFBDT(NDTYP)+1
      IF(IRUNS.NE.IPRINT) GOTO 340
      AKIL=8H MISSED
      IF(IDAM.GT.0)AKIL=8H HIT HIM
      PRINT 9003,NDF,NDTYP,IIS,NTGTYP(IIS),AKIL,PRBITY
 9003 FORMAT(' DEF NO.'I5,' TYPE',I2,' FIRED AT INT NO. ',
     1I3,' TYPE ',I1,' AND',A8,' PROB= ',F7.3)
  340 IF(IDAM.LT.1) GO TO  475
      TGTYNW(IIS)=TGTYNW(IIS)+100000.
      IF(NGTAWT.GT.0)CALL UNIT
      LEFTIN=LEFTIN-1
      TGTVEL(IIS)=0.
      TMTOFR(IIS)=9999.
      CALL STINT(ISVIFA,IIS,K,IBIT,KDFTTN,2)
      INTYP=NTGTYP(IIS)
      NKILLD(INTYP)=NKILLD(INTYP)+1
      NKILLT=NKILLT+1
      IF(NTTTCS(INTYP).GT.0) NSPLFT=NSPLFT-1
      KI=IIS
      XFIX=0.0
      IF(NTTTMD(INTYP).GT.0)CALL DIVSET
  475 J=0
      DO 485 I=1,NTGO
      CALL STINT(ISVIFA,I,K,IBIT,KDFTTN,3)
      IF(IBIT.LT.1) GO TO 485
```

Figure 30. (Continued)

```
      NRFIRD(I)=NRFIRD(I)+1
      IF(NRFIRD(I)-NRBA)485,480,485
  480 TMTOFR(I)=0.
      J=1
  485 CONTINUE
      IF(J)50,990
C
C  THIS IS AN INTRUDER FIRING AT A DEFENDER
C
  500 NINTT=NTGTYP(M)
      IF(NRADFI(M).LT.1)GO TO 900
      DO 600 I=1,5
      IPRR=LDFDPR(NINTT,I)
      IF(IPRR.LT.1) GO TO 1000
      DO 590 J=1,NDFWD
      IF(IWTDEF(J).NE.IPRR) GO TO 590
      DO 580 K=1,NDFA
      IF(NDEFEA(K,J).LT.1) GO TO 580
      CALL STINT(ISVIFA,M,K,IBIT,KDFTTN,3)
      IF(IBIT.LT.1) GO TO 580
      GO TO 620
  580 CONTINUE
  590 CONTINUE
  600 CONTINUE
      GO TO 1000
  620 TMTOFR(M)=TMBRI(NINTT)
      KI=K
      IDAM=2
      NDF=NDEFEA(K,J)
      ISHOT=1
      IIS=M
      CALL DIRFIR(IDAM)
      NRADFI(IIS)=NRADFI(IIS)-1
      IF(NRADFI(IIS).LT.1)TMTOFR(M)=9990.
      NRFBIT(NINTT)=NRFBIT(NINTT)+1
      IF(IRUNS.NE.IPRINT) GO TO 640
      AKIL=8H MISSED
      IF(IDAM.GT.0) AKIL= 8H HIT HIM
      PRINT 9005,M,NINTT,NDF,IWTDEF(NDF),AKIL,PRBITY
 9005 FORMAT(' INT NO. ',I4,' TYPE',I2,' FIRED AT DEF NO. ',
     1I3,' TYPE ',I1,' AND',A8,' PROB= ',F7.3)
  640 IF(IDAM.LT.1) GO TO 990
      NDEFEA(K,J)=-NDF
      NDTYP=IWTDEF(NDF)
      NDFDAM(NDTYP)=NDFDAM(NDTYP)+1
      TMTOFR(NDF+100)=9999.
      GO TO 990
  750 IVAP=M-120
      IF(NVLIDF(IVAP).LT.1)GO TO 900
      CALL NDFIRE
      TMTOFR(M)=TDBIFV(IVAP)
      NVLIDF(IVAP)=NVLIDF(IVAP)-1
      ISHOT=1
      GO TO 990
  900 TMTOFR(M)=9990.
      GO TO 1000
  990 IF(TMTOFR(M).GT.TRAVTM)GO TO 1000
      GO TO 50
 1000 CONTINUE
C
C
      IF(ISHOT)50,1050
 1050 IF(NOBTP2-17)20,15,20
      END
```

Figure 30. (Continued)

```
      SUBROUTINE STINT(ISV,INT,IT,IBIT,KDFTTN,N)
      DIMENSION ISV(30),KDFTTN(100)
      K=INT
      KT=IT
      I=1
      IF(K.LT.59) GO TO 10
      KT=IT+15
      K=K-59
   10 GO TO (20,50,100),N
   20 ISV(KT)=ISV(KT).OR.SHIFT(I,K)
      KDFTTN(INT)=KDFTTN(INT)+1
      RETURN
   50 ISW=0
      J=ISW
      KK=J.OR.SHIFT(I,K)
      KK=.NOT.KK
      ISV(KT)=ISV(KT).AND.KK
      KDFTTN(INT)=KDFTTN(INT)-1
      RETURN
  100 IBIT=SHIFT(ISV(KT),-K).AND.1B
      RETURN
      END
```

Figure 30. (Continued)

```
      SUBROUTINE EXPSWP
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUDPRB(7),D3DEL,FI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LDFOPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MTFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NDVT,NGTAW(100),NGTAWT,NGTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),PDLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PRDTNO(5,7),PRKLO(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10)
C....*YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
      XLOC=OBX
      KT=KTSAV(ISAVE)
      IOB(KT)=-1
      NB=NOBTP2
      IF(IRUNS.EQ.IPRINT) WRITE(6,1000)
 1000 FORMAT(' THE EXPLOSIVE SWEEP ROUTINE HAS REMOVED THE ',
     *'FOLLOWING MINES')
      IF(LCFOPT.GT.1)GO TO 20
      YDIST=OBY+ALNGLC
      RANGE=AWIDLC
      GO TO 50
   20 YLOC=OBY+DFTFAE
      YDIST=YLOC+RADFAE
      YST=YLOC-RADFAE
      RANGE=RADFAE**2
   30 KT=KT+1
      IF(IOB(KT).LT.0) GO TO 30
      IWORD=IOB(KT)
      CALL UNPACK
      IF(NOBTP2-8)40,200,30
   40 IF(OBY.LT.YST) GO TO 30
      GO TO 60
   50 KT=KT+1
      IF(IOB(KT).LT.0) GO TO 50
      IWORD=IOB(KT)
      CALL UNPACK
      IF(NOBTP2-8)60,200,50
   60 IF(OBY.GT.YDIST) GO TO 200
      DIST=ABS(XLOC-OBX)
      IF(LCFOPT.GT.1)DIST=DIST**2+(YLOC-OBY)**2
      IF(DIST.GT.RANGE) GO TO 50
      RN=RANF(DUMMY)
      IF(RN.GT.PDLCF)GO TO 50
      IF(IRUNS.EQ.IPRINT) WRITE(6,1010) NOBTP2,OBX,OBY
 1010 FORMAT(' OBS TYPE= ',I5,'  OB X= ',F8.2,'  OB Y= ',F8.2)
      NMSWPT(NOBTP2)=NMSWPT(NOBTP2)+1
      NMDET(NOBTP2)=NMDET(NOBTP2)+1
      CALL BOOM(IDET,1)
      IOB(KT)=-1
      GO TO 50
```

Figure 30. (Continued)

```
200 DO 250 I=1,NTGO
    IF(TGTYNW(I).LT.99969.)GO TO 250
    IF(NCTAW(I).NE.NCTAW(ISAVE))GO TO 250
    SWPDEL(I)=SWPDEL(I)+TMDLCF
    DELATM(I)=TMDLCF
    TGTVEL(I)=0.
250 CONTINUE
    OBX=XLOC
    NOBTP2=NB
    RETURN
    END
```

Figure 30. (Continued)

```
      SUBROUTINE TGTMOV
      COMMON ACEP(5,2),ADEP(20),AEI(5,5,4),AI(20),AIMPTX(50),AIMPTY(50),
     *ALNGLC,ANGIMP(10),AREL(5,2),AREP(20),AWIDLC,AYYVP(10),DBFAE,
     *DEFHT(5),DEFL(5),DEFRAD(5),DEFW(5),DEFX(20),DEFY(20),DELATM(100),
     *DEP(10),DFTFAE,DIRATK(10),DIRDIS(100),DMPIIX(10,10),DMPIIY(10,10),
     *DUDPRB(7),D3DEL,EI(5,5,2),ID,IDISOP,IDP(20,15,2),IEND,
     *IIS,IMINE,INDFA,INTIME(7),IOB(5000),IPO,IPRINT,IRNK(7),IRTFIR,
     *IRUNS,ISAVE,ISBL,ISVIFA(30),ISVLST,ISYMP(3),ISYP,IT,ITEROP,
     *ITGTPR(5,5),IVAP,IVEL,IWORD,IWTDEF(20),IWTVAP(10)
      COMMON JMARKI,JSELDS(7),KABOOM(547),KDFTTN(100),KNRS,KOUNT(7),
     *KTSAV(100),KI,LCFOPT,LCFTT,LDFDPR(5,5),LEFTIN,MADIV,MIFBT(7),
     *MODE,MIFA(50),MUSH,NAP,NCTAW(100),ND,NDEFEA(15,20),NDF,NDFA,
     *NDFAA,NDFDAM(5),NDFWD,NDFWT,NDVT,NGTAW(100),NGTAWT,NGTAWI(100),
     *NIDBT(5),NITBT(5),NKILL(5),NKILLD(5),NKILLI(5),NKILLT,NMDET(7),
     *NMIN(7),NMSWPT(7),NMT,NOB,NOBEVT,NOBTP2,NOIT,NOSTAT,NRAD(5),
     *NRADFD(20),NRADFI(100),NRAI(5),NRBA,NRFBDT(5),NRFBIT(5),
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),PDLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PRDTND(5,7),PRKLD(5,7),
     *PROBIL(840),PRSWDD(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7)
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDDF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TOBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XOMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
C....
      DO 600 I=1,NTGO
      IF(TGTYNW(I).GT.99990.) GO TO 600
      IF(TGTVEL(I).GT.0.) GO TO 500
      DELATM(I)=DELATM(I)-TRAVTM
      IF(DELATM(I).GT.0.00001) GO TO 550
      TGTVEL(I)=TGTSPD
      DTM=ABS(DELATM(I))
      DELATM(I)=0.
      TGTYNW(I)=TGTYNW(I)+TGTSPD*DTM
      TIMEMV(I)=TIMEMV(I)+DTM
      IF(TMTOFR(I).GT.9000.) GO TO 600
      TMTOFR(I)=TMTOFR(I)-DTM
      IF(TMTOFR(I).LT.0.)TMTOFR(I)=0.
      GO TO 600
  500 TGTYNW(I)=TGTYNW(I)+TGTSPD*TRAVTM
      TIMEMV(I)=TIMEMV(I)+TRAVTM
  550 IF(TMTOFR(I).GT.9000.) GO TO 600
      TMTOFR(I)=TMTOFR(I)-TRAVTM
      IF(TMTOFR(I).LT.0.) TMTOFR(I)=0.
  600 CONTINUE
      IF(NDFWD.LT.1) GO TO 750
      NEND=NDFWD+100
      DO 700 I=101,NEND
      IF(TMTOFR(I).GT.9000.) GO TO 700
      TMTOFR(I)=TMTOFR(I)-TRAVTM
      IF(TMTOFR(I).LT.0.) TMTOFR(I)=0.
  700 CONTINUE
  750 IF(NVAP.LT.1) RETURN
      NEND=120+NVAP
      DO 900 I=121,NEND
      IF(TMTOFR(I).GT.9000.) GO TO 900
      TMTOFR(I)=TMTOFR(I)-TRAVTM
      IF(TMTOFR(I).LT.0.) TMTOFR(I)=0.
  900 CONTINUE
      RETURN
      END
```

Figure 30. (Concluded)

SECTION V

SIMULATION MODEL

SEMAC is capable of simulating the passage of up to 100 intruder targets of five different types through an engagement area defended by direct and indirect fire. The program can consider up to 50 sortie aimpoints, 32,767 mines of seven different types, ten indirect fire volley aimpoints with five different types of indirect fire munitions, and 20 defenders with five different direct fire weapon types. The intruders can be in any formation desired, and are masked from the defenders in selected portions of the engagement area by terrain shielding. The intruders are capable of return fire and may employ a variety of sweeping techniques.

TABLES AND ARRAYS

The three probability functions employed in SEMAC are entered as tables which have been set at a maximum of three sets of eight pairs of values for each target/mine combination being evaluated. All probability inputs are stored in PROBIL(840), and all corresponding range values are stored in RANGPR(840). The first eight entries in each table contain the probabilities of mine detection and corresponding ranges for the first target type and the first mine type. The second eight locations contain the probabilities that a detonated mine of the first type will damage a target of the first type and corresponding ranges. The third eight entries contain the probabilities that a mine of the first type will detonate when encountered by a target of the first type. The next three sets of eight entries contain similar data for the first target type and the second mine type, etc.

In addition, allocation is made in COMMON locations for a number of other arrays. The COMMON statements which are used in SEMAC are shown below.

```
      COMMON ACEP(5.2).ADEP(20) AEI(5.5.4).AI(20).AIMPTX(50).AIMPTY(50).
     *ALNGLC.ANGIMP(10).AREL(5.2).AREP(20).AWIDLC.AYYVP(10).DBFAE.
     *DEFHT(5).DEFL(5).DEFRAD(5).DEFW(5).DEFX(20).DEFY(20).DELATM(100).
     *DEP(10).DFTFAE.DIRATK(10).DIRDIS(100).DMPIIX(10.10).DMPIIY(10.10).
     *DUDPRB(7).D3DEL.EI(5.5.2).ID.IDISOP.IDP(20.15.2).IEND.
     *IIS.IMINE.INDFA.INTIME(7).IOB(5000).IPO.IPRINT.IRNK(7).IRTFIR.
     *IRUNS.ISAVE.ISBL.ISVIFA(30).ISVLST.ISYMP(3).ISYP.IT.ITEROP.
     *ITGTPR(5.5).IVAP.IVEL.IWORD.IWTDEF(20).IWTVAP(10)
      COMMON JMARKI.JSELDS(7).KABOOM(547).KDFTTN(100).KNRS.KOUNT(7).
     *KTSAV(100).KI.LCFOPT.LCFTT.LDFDPR(5.5).LEFTIN.MADIV.MIFBT(7).
     *MODE.MTFA(50).MUSH.NAP.NCTAW(100).ND.NDEFEA(15.20).NDF.NDFA.
     *NDFAA.NDFDAM(5).NDFWD.NDFWT.NDVT.NGTAW(100).NGTAWT.NGTAWI(100).
     *NIDBT(5).NITBT(5).NKILL(5).NKILLD(5).NKILLI(5).NKILLT.NMDET(7).
     *NMIN(7).NMSWPT(7).NMT.NOB.NOBEVT.NOBTP2.NOIT.NOSTAT.NRAD(5).
     *NRADFD(20).NRADFI(100).NRAI(5).NRBA.NRFBDT(5).NRFBIT(5).
     *NRFIRD(100),NRS,NSPLFT,NSTICK(50),NSUB(5),NTCOL(100),NTGO,NTGTP,
     *NTGTYP(100),NTLCIF(10),NTLOST,NTTTCS(5),NTTTMD(5),NTTTRP(5),NVAP,
     *NVFAEA(10),NVLIDF(10),NWEPV(10),OBX,OBY,OBYPRT,PATRAD(5),POLCF
      COMMON PHD(5,5),PPEAF(7),PRBITY,PRDTNO(5,7),PRKLO(5,7),
     *PROBIL(840),PRSWDO(5,7),RADFAE,RANGPR(840),RELRND(5),RELSUB(5),
     *REP(10),RN,ROTDMPX(10,10),ROTDMPY(10,10),RSP(5),S(100),SECON(7),
     *SIGAD(50),SIGAR(50),SIGBD(50),SIGBR(50),STATAL(5,52),SWPDEL(100),
     *SYMDUF(5,7),SYMDIF(5,7),SYMDIS(7,7),SYMMAX(3),TARHT(5),TARL(5),
     *TARRAD(5),TARW(5),TDBIFV(10),TGTDEL(100),TGTOVL,TGTSPD,
     *TGTVEL(100),TGTVL2,TGTVSV,TGTXOL(100),TGTYNW(100),TGTYOL(100),
     *TGTYSV,THETA,THRSIG(5,5),TIMEMV(100),TMBRD(5),TMBRI(5),TMDLCF,
     *TMSWP(7),TMTOFR(130),TOTSIM,TRAVTM,XCYCLE(7),XDMP(10,10),XFIX,
     *XMAX,XMIN,XODEF(20),XOVP(10),
     *XRDFO(30),XROAD(11),XSWATH(50),XWIDTH,YDIV(100),YDMP(10,10),
     *YLENGTH,YODEF(20),YOVP(10),YRDFO(30),YROAD(11),YSWATH(50)
```

All variables which appear in these statements are individually defined in the List of Symbols and Abbreviations (Simulation Model).

DISCUSSION OF SIMULATION

The remainder of this section discusses in detail the coding of the various subroutines.

Program MAIN

Program MAIN exercises control over the simulation by calling the various processing subroutines in a manner defined by the program logic. The first executable statement:

```
      KREAD = 0
```

initializes KREAD at the beginning of the job. The next statement:

```
    5 CALL READIN (KREAD)
```

transfers control to Subroutine READIN. This subroutine reads the data for the first case (KREAD=0) and performs several iteration independent calculations. The statement:

```
   20 CALL SETUP
```

is the return point for each iteration. Subroutine SETUP performs iteration-dependent calculations. The statements:

```
25 CALL ROAD
   CALL SORT(IOB,NOB)
   IF((EFTIN.EQ.0)) GO TO 160
```

transfer control to Subroutine ROAD to initialize target travel on a travel path segment. Subroutine SORT performs a Singleton sort on the event information array [IOB(5000)] to order the array by increasing event Y coordinate. If all targets have been damaged or have breached the engagement area, transfer is made to determine if the last travel path segment has been traversed. The next statements:

```
30    CALL LOOPS
      TGTVSV=TGTVEL(ISAVE)
      IPO=IM
      ISYP=0
      KT = KTSAV(ISAVE)
      IWORD = IOB(KT)
      CALL UNPACK
      OBYPRT=OBY
```

call Subroutine LOOPS to determine the next event and unpack the information for the event. The statement:

```
CALL CKEVTM
```

provides a transfer to Subroutine CKEVTM to process all time oriented events involving direct and indirect fire. If the event target was damaged by direct or indirect fire, the next statement:

```
IF((TGTYNW(ISAVE).GT.99990.) GO TO 110
```

removes this target from further consideration. Otherwise, the following statements:

```
IF((TGTVSV.GT.0.0))GO TO 50
KTSAV(ISVLST)=KTSAV(ISVLST)-1
GO TO 30
```

determine if the event target is in a delay condition and provides transfer to Subroutine LOOPS to determine the next event. The following statement:

```
50 GO TO (72,72,72,72,72,72,72,75,72,72,72,72,72,72,72,
  *80,110,100,77) NOBTP2
```

provides transfers to the proper subroutine based on the event. If the event is one for a target/mine encounter, the next statement:

```
72 CALL TGTMIN
```

calls Subroutine TGTMIN to evaluate the target/mine interactions. If any targets are associated with other targets as a group and if a target is damaged in this event, the next statements:

```
IF(NGTAHT.GE.1.AND.ISYP.EQ.2) CALL UNIT
GO TO 110
```

provide transfer to Subroutine UNIT to determine whether any unit movement of targets is required. If the event is one for a target/travel path boundary, the statements:

```
75 CALL EVENTC
   GOTO 110
```

calls Subroutine EVENTC to evaluate the target/boundary event. The next statements:

```
77 IF(TGTXOL(ISAVE).NE.OBX.OR.NTGTYP(ISAVE).NE.LCFT)GO TO 150
   CALL EXPSWP
   GO TO 110
```

provide a call to Subroutine EXPSWP if the event target has reached a point along a travel path segment where line charge or fuel air explosive sweeping devices will be employed.

If the event target is leading the column that initiates an indirect fire volley, the following statements:

```
80  IF(IT.NE.NCTAW(ISAVE))GO TO 150
    IVAP=IMINE
    CALL NDFIRE
    CALL BOOM(IDET,1)
    INDFA=1
    IDB(KT)=-1
    NVLIDF(IVAP)=NVLIDF(IVAP)-1
    TMTOFR(IVAP+120)=TDBIFV(IVAP)
    GO TO 110
```

call Subroutine NDFIRE to evaluate the indirect fire volley at the aimpoint. Subroutine BOOM is called to set the flag bit on for this event to insure that the remaining volleys for this aimpoint arrive on a time basis. When a target has encountered a direct fire area exit boundary, the following statements:

```
100 CALL STINT(ISVIFA,ISAVE,IT,IBIT,KDFTTN,2)
    IF(KDFTTN(ISAVE).GT.0) GO TO 102
    NRFIRD(ISAVE)=0
    TMTOFR(ISAVE)=9990
102 JAA=0
    DO 105 J=1,30
    IF(ISVIFA(J))103,105
103 JAA=J
105 CONTINUE
    IF(JAA.LT.1) GO TO 109
    NDFA=MOD(JAA,15)
    IF(NDFA.LT.1)NDFA=15
    GO TO 110
109 NDFA=0
```

provide a call to Subroutine STINT to set the flag bit off for the event target in the direct fire area. This eliminates the target from any consideration by direct fire. This section of coding also determines the largest direct fire area number that contains at least one intruder. The next statements:

```
110 IF(NOBEVT.GT.0.AND.IRUNS.EQ.IPRINT)
   *   CALL PRINTO
    NOBEVT=IABS(NOBEVT)
```

transfer control to Subroutine PRINTO to print the optional output if required and if a mine is swept or detonated in the event. The next statements:

```
    IF(INDFA)130,150
130 JAA=0
```

```
      DO 140 I=1,NVAP
      IF(NVLIDF(I))140,140,135
  135 JAA=1
  140 CONTINUE
      INDFA=JAA
```

determine if all volleys have been fired at every indirect fire aimpoint and sets the indirect fire flag. If all targets which are capable of sweeping have been damaged or have breached the minefield, the statements:

```
  150 IF(NSPLFT.GT.0.OR.KNRS.NE.NRS) GO TO 155
      NSPLFT=99999
      DO 152 I=1,NTGO
      IF(TGTYNW(I).LT.99970.) TGTVEL(I)=TGTOVL
  152 CONTINUE
      TGTSPD=TGTOVL
```

set the undamaged target velocities to normal speed. The next statement:

```
  155 IF(LEFTIN.GT.0) GO TO 30
```

branches to Subroutine LOOPS if any targets have not completed traversing the travel path segment and have not been damaged. If all targets are damaged or have traversed the travel path segment, the statement:

```
  160 IF(KNRS.NE.NRS) GO TO 25
```

branches to Subroutine ROAD if more travel path segments are to be traversed. Otherwise, the statements:

```
      CALL PRINTR
      IF (IRUNS .LT. NOIT) GO TO 20
```

call Subroutine PRINTR to print the results for the iteration and, if more iterations are required, branch to Subroutine SETUP to prepare for the next iteration. If all iterations have been completed, the statements:

```
      KREAD = 1
      GO TO 5
      END
```

transfer control to Subroutine READIN to read data cards for the next case, or the program is terminated if all cases have been processed.

Subroutine READIN

This subroutine reads in the data cards and performs initial calculations which are independent of the iteration. The statements:

```
DIMENSION ORX(4),ORY(4),XYMS(4),RNGSV(3)
DIMENSION HOL(8),SECOFF(7),PROBTP(8),RANGTP(8)
DATA ITEST/5H  999/
```

provide local storage for input variables and initialize the value of ITEST. If this is the first call to Subroutine READIN, the statements:

```
      REWIND 2
      WRITE(6,1480)
      IF(KREAD.EQ.1) GO TO 24
      CALL REPRNT
 8010 DO 7 I=1,840
      PROBIL(I) = 0.0
      RANGPR(I) = 0.0
 7    CONTINUE
      ND=0
      DO 8 J=1,15
      DO 8 I=1,20
    8 NDEFEA(J,I)=0
      LCFOPT=0
      MADIV=0
      DO 9 I=1,5
      NRAI(I)=NRAD(I)=0
      TARRAD(I)=TARL(I)=TARW(I)=TARHT(I)=0.
      REP(I)=REP(I+2)=0.
      DEP(I)=DEP(I+2)=0.
      NSUB(I)=1
      DO 9 J=1,7
      SYMDDF(I,J)=0.
    9 SYMDIF(I,J)=0.
      DO 10 I=1,7
      TMSWP(I)=SECON(I)=SECOFF(I)=XCYCLE(I)=0
      DO 10 J=1,7
   10 SYMDIS(I,J)=0.
      IEND= 0
```

call System Subroutine REPRNT to list the input data on the output device, and initialize several variables at the beginning of the job. The statements:

```
 24      IEND= IEND+ 1
         JMARK1=1
         IRUNS=0
         DO 23 I=1,100
      23 DELATM(I)=0
      DO 25 I=1,7
   25 INTIME(I)=0
```

initialize variables at the beginning of each data set. The first card of each subdeck, which must be a title card, is read by the statements:

```
      READ(4,9000) HOL
      DECODE(80,9000,HOL) INPUT
      IF(INPUT.EQ.ITEST) CALL EXIT
```

DECODE(N,M,HOL) is a Control Data Corporation system function which provides for the decoding of N characters of Hollerith information by Format M. A check is made on the first card of each subdeck to determine if it is a Card Type 999, which signals the end of the job. The statements:

```
      DO 38 J=1,52
      DO 38 I=1,5
      STATAL(I,J)=0.
38    CONTINUE
   50 READ(4,9000)HOL
 9000 FORMAT(8A10)
      DECODE(5,9001,HOL) INPUT
 9001 FORMAT(I5)
```

are executed next to initialize variables, read a data card, and decode the card type. Branches to the appropriate section of coding to obtain the data values on the card are provided by the statements:

```
      IF(INPUT.EQ.99) GO TO 7000
      IF(INPUT.GT.1000) GO TO 5900
      GO TO(100,200,300,400,500,600,700,800,900,1000,1100,1200,1300,1400
     *,1500,1600,1700,1800,1900,2000,2100,2200,2300,2400) INPUT
```

The following sections are similar in that they decode input data on a particular card. For Card Type 1, the decoding statements are:

```
  100 DECODE(80,9002,HOL)NAP,NTGO,NTGTP,NOIT,NOSTAT,IPRINT,SEED,
     *NMT,MODE,NVAP,NDFAA,NDFWD,NRBA
 9002 FORMAT(5X,6I5,F10.2,6I5)
      IF(SEED.LE.0.) SEED=RANF(DUMMY)
      CALL RANSET(SEED)
      GO TO 50
```

If the value of SEED is zero, a call to RANF (the Control Data Corporation system uniform random number generator) is performed to determine a starting value. The call to RANSET causes RANF to start with the value of SEED. For Card Types 2, 3, and 4, the decoding statements are:

```
  200 DECODE(80,9003,HOL)LCFOPT,YLENGTH,XWIDTH,THETA,D3DEL,
     *(ISYMP(I),I=1,3),ISBL,ITEROP,IDISOP
 9003 FORMAT(5X,I5,2F10.2,2F5.2,4I5,I2,I3)
      GO TO 50
  300 DECODE(80,9004,HOL)NTN,NTGTYP(NTN),NCTAW(NTN),NGTAW(NTN),
     *TGTXOL(NTN),TGTYOL(NTN),N1,N2,N3,N4,T1,T2
      IF(N1.LT.1)GO TO 50
      NTGTYP(N1)=N2
      NCTAW(N1)=N3
      NGTAW(N1)=N4
      TGTXOL(N1)=T1
      TGTYOL(N1)=T2
 9004 FORMAT(2(5X,I5,I1,I4,I5,2F10.2))
      GO TO 50
  400 DECODE(80,9005,HOL)ITYP,TARL(ITYP),TARW(ITYP),TARRAD(ITYP),
     *TARHT(ITYP),TMBRI(ITYP),NRAI(ITYP),(LDFDPR(ITYP,I),I=1,5),
     *NTTTCS(ITYP),NTTTMO(ITYP),NTTTRP(ITYP)
      IF(NTTTMO(ITYP).GT.0)MADIV=1
 9005 FORMAT(5X,I5,4F10.2,F5.2,I5,5I1,3I5)
      GO TO 50
```

For Card Types 5, 6, 7, 8, and 9, the decoding statements are:

```
  500 DECODE(80,9091,HOL)IVAP,IROAD,XOVP(IVAP),YOVP(IVAP),AYYVP(IVAP),
     *NVFAEA(IVAP),NWEPV(IVAP),IWTVAP(IVAP),NTLCIF(IVAP),TDBIFV(IVAP)
 9091 FORMAT(10X,2I5,3F10.2,4I5,F10.2)
      IVPO=IFIX(XOVP(IVAP)*100.)
      XOVP(IVAP)=FLOAT(IVPO*100+IROAD*ISIGN(1,IVPO))
      GO TO 50
  600 DECODE(80,9090,HOL)IVAP,IWEPV,DMPIIX(IVAP,IWEPV),
     *DMPIIY(IVAP,IWEPV)
 9090 FORMAT(10X,2I5,2F10.2)
      GO TO 50
  700 DECODE(80,9015,HOL)IVAP,IWT,ANGIMP(IVAP),REP(IVAP),DEP(IVAP),
     *NSUB(IWT),RELSUB(IWT),PATRAD(IWT),RELRND(IWT)
 9015 FORMAT(5X,2I5,F5.2,2F10.2,I5,3F10.2)
      GO TO 50
  800 DECODE(80,9089,HOL)NRS,TGTOVL,TGTVL2
 9089 FORMAT(10X,I5,2F10.2)
      TGTOVL=TGTOVL*88.
      TGTVL2=TGTVL2*88.
      N=NRS+1
      READ(4,9007)(XROAD(I),YROAD(I),I=1,N)
 9007 FORMAT(8F10.2)
      GO TO 50
  900 DECODE(80,9013,HOL)IAP,MTFA(IAP),NSTICK(IAP),AIMPTX(IAP),
     *AIMPTY(IAP),YSWATH(IAP),XSWATH(IAP)
 9013 FORMAT(5X,3I5,4F10.2)
      GO TO 50
```

The value 88 is used to convert miles per hour to feet per minute. For Card Types 10 and 11, the decoding statements are:

```
1000 DECODE(80.9012.HOL)IAP.SIGAR(IAP).SIGAD(IAP).SIGBR(IAP).SIGBD(IAP)
9012 FORMAT(5X.I5.4F10.2)
     GO TO 50
1100 DECODE(80.9009.HOL)MT.JSELDS(MT).IMSWP(MT).DUDPRB(MT).PPEAF(MT)
9009 FORMAT(10X.2I5.3F10.2)
     IF(JSELDS(MT).GT.0) GO TO 50
     DO 902 M=1.NAP
     IF(MTFA(M).EQ.MT) GO TO 903
 902 CONTINUE
 903 J=0
 905 READ(4.9007)(ORX(I).ORY(I).I=1.4)
     DO 910 I=1.4
     WRITE(2) ORX(I).ORY(I).MT
     IF(J+I.EQ.NSTICK(M)) GO TO 50
 910 CONTINUE
     J=J+4
     GO TO 905
```

If the value of JSELDS(MT) is zero, the nominal X and Y coordinates of each mine (measured relative to the sortie aimpoint) are read in and written on Tape 2. For Card Types 12, 13, and 14, the decoding statements are:

```
1200 DECODE(80.9010.HOL)MT.(SYMDIS(MT.J).J=1.7)
9010 FORMAT(10X.I5.7F5.2)
     GO TO 50
1300 DECODE(80.9010.HOL)IWT.(SYMDDF(IWT.J).J=1.7)
     GO TO 50
1400 DECODE(80.9010.HOL)IWT.(SYMDIF(IWT.J).J=1.7)
     GO TO 50
```

For Card Types 15, 16, and 17, the decoding statements are:

```
1500 DECODE (80.9011.HOL) MT.SECON(MT).SECOFF(MT).KOUNT(MT).IRNK(MT)
9011 FORMAT (10XI5.2F5.2.2I5)
     INTIME(MT)=1
     GO TO 50
1600 DECODE(80.9094.HOL)NUMDEF.IWTDEF(NUMDEF).XODEF(NUMDEF).
    *YODEF(NUMDEF).(NDEFEA(J.NUMDEF).J=1.15)
9094 FORMAT(5X.2I5.2F10.2.15I2)
     GO TO 50
1700 DECODE(80.9093.HOL)NDF.IROAD.(XYMS(I).I=1.4)
9093 FORMAT(5X.2I5.4F10.2)
     L=0
     DO 1705 I=1.2
     ND=ND+1
     IXYM1=IFIX(XYMS(I+L)*100.)
     XRDFO(ND)=FLOAT(IXYM1+ISIGN(1.IXYM1)*IROAD)
     IXYM2=IFIX(XYMS(I+2)*100.)
     YRDFO(ND)=FLOAT(IXYM2+ISIGN(1.IXYM2)*NDF)
     L=L+1
1705 CONTINUE
     GO TO 50
```

For Card Types 18, 19, and 20, the decoding statements are:

```
 1800 DECODE(80,9016,HOL)I1,J1,PHD(I1,J1),I2,J2,P2,I3,J3,P3,
     *I4,J4,P4,I5,J5,P5
 9016 FORMAT(5X,5(2I5,F5.2))
      IF(I2.LT.1) GO TO 50
      PHD(I2,J2)=P2
      IF(I3.LT.1)GO TO 50
      PHD(I3,J3)=P3
      IF(I4.LT.1)GO TO 50
      PHD(I4,J4)=P4
      IF(I5.LT.1) GO TO 50
      PHD(I5,J5)=P5
      GO TO 50
 1900 DECODE(80,9017,HOL)I1,J1,N1,EV1,I2,J2,N2,EV2,I3,J3,N3,EV3
 9017 FORMAT(5X,3(3I5,F10.2))
      EI(I1,J1,1)=N1
      EI(I1,J1,2)=EV1
      IF(I2.LT.1) GO TO 50
      EI(I2,J2,1)=N2
      EI(I2,J2,2)=EV2
      IF(I3.LT.1) GO TO 50
      EI(I3,J3,1)=N3
      EI(I3,J3,2)=EV3
      GO TO 50
2000  DECODE(80,9050,HOL) NDFTYP,DEFL(NDFTYP),DEFW(NDFTYP),
     *DEFRAD(NDFTYP),DEFHT(NDFTYP),TMBRD(NDFTYP),NRAD(NDFTYP),
     *(ITGTPR(NDFTYP,I),I=1,5)
9050  FORMAT(5X,I5,4F10.2,F5.2,I5,5I1)
      GO TO 50
```

The following statements decode Card Types 21, 22, 23, and 24.

```
2100  DECODE(80,9051,HOL) I1,AI1,AREP1,ADEP1,I2,AI2,AREP2,ADEP2
9051  FORMAT(5X,I5,3F10.2,5X,I5,3F10.2)
      AI(I1)=COS(AI1*.01745329)
      AREP(I1)=AREP1
      ADEP(I1)=ADEP1
      IF(I2.LT.1) GO TO 50
      AI(I2)=COS(AI2*.01745329)
      AREP(I2)=AREP2
      ADEP(I2)=ADEP2
      GO TO 50
2200  DECODE(80,9052,HOL) I,J,K,N,AEV,AREL1,ACEP1
9052  FORMAT(5X,4I5,F10.2,F5.2,F10.2)
      AEI(I,J,2*K-1)=N
      AEI(I,J,2*K)=AEV
      L=I
      IF(K.GT.1) L=J
      AREL(L,K)=AREL1
      IF(N.GT.1) ACEP(L,K)=ACEP1
      GO TO 50
2300  DECODE(80,9053,HOL) I1,J1,K1,IDP1,I2,J2,K2,IDP2,I3,J3,K3,IDP3
9053  FORMAT(5X,3(4I5,5X))
      IDP(I1,J1,K1)=IDP1
      IF(I2.LT.1) GO TO 50
      IDP(I2,J2,K2)=IDP2
      IF(I3.LT.1) GO TO 50
      IDP(I3,J3,K3)=IDP3
      GO TO 50
 2400 DECODE(80,9029,HOL)LCFTT,DBFAE,DFTFAE,RADFAE,ALNGLC,
     *AMIDLC,TMDLCF,PDLCF
 9029 FORMAT(5X,I5,7F10.2)
      GO TO 50
```

For card types greater than 1000, the decoding statements are:

```
6900 DECODE(80,9008,HOL) NT,NM,NTB,(PROBTP(I),I=1,8)
9008 FORMAT(1X,I1,I2,I1,F5.2,7F10.2)
     READ(4,9008) NT,NM,NTB,(RANGTP(I),I=1,8)
     NTABLE=(NT-1)*21+(NM-1)*3+NTB
     LL=8*(NTABLE-1)
     DO 6910 I=1,8
     PROBIL(LL+I)=PROBTP(I)
6910 RANGPR(LL+I)=RANGTP(I)
     GO TO 50
```

Transfer is made to statement 6900 for input of each probability function. The target type, mine type, and table number are decoded, and the probability and corresponding range values are stored in appropriate array locations. When a Card Type 99 signals the end of the data for the subdeck, the following section performs various calculations required for the case. The statements:

```
7000 DO 7005 I=1,NMT
     XCYCLE(I)=SECON(I)+SECOFF(I)
     NMIN(I)=0
     DO 7005 J=1,NAP
     IF(MTFA(J).EQ.I) NMIN(I)=NMIN(I)+NSTICK(J)
7005 CONTINUE
     IRTFIR=0
     DO 7006 I=1,5
     IF(NRAI(I).LT.1) GO TO 7006
     IRTFIR=1
7006 NITBT(I)=0
     NGTAWT=0
     DO 7008 I=1,NTGO
     N=NTGTYP(I)
     NGTAWT=NGTAWT+NGTAW(I)
7008 NITBT(N)=NITBT(N)+1
```

compute the duration of the fuze timing cycle (if any), the total number of mines emplaced by type, and the total number of targets by type. If sympathetic detonations for mines are being evaluated, the statements:

```
     IF(ISYMP(1).LT.1) GO TO 7015
     SYMMAX(1)=0.
     DO 7010 I=1,NMT
     DO 7010 J=1,7
     SYMDIS(I,J)=SYMDIS(I,J)**2
7010 SYMMAX(1)=AMAX1(SYMMAX(1),SYMDIS(I,J))
     SYMMAX(1)=SQRT(SYMMAX(1))
7015 RSPMAX=0.
```

compute the maximum distance at which sympathetic detonations can occur. If sympathetic detonations are being evaluated for direct fire rounds, the following statements:

```
      IF(ISYMP(2).LT.1) GO TO 7017
      SYMMAX(2)=0.
      DO 7016 I=1,5
      DO 7016 J=1,7
      SYMDDF(I,J)=SYMDDF(I,J)**2
 7016 SYMMAX(2)=AMAX1(SYMMAX(2),SYMDDF(2))
      SYMMAX(2)=SQRT(SYMMAX(2))
```

compute the maximum distance at which sympathetic detonations can occur. If sympathetic detonations for indirect fire rounds are being evaluated, the following statements:

```
 7017 IF(ISYMP(3).LT.1) GO TO 7019
      SYMMAX(3)=0.
      DO 7018 I=1,5
      DO 7018 J=1,7
      SYMDIF(I,J)=SYMDIF(I,J)**2
 7018 SYMMAX(3)=AMAX1(SYMMAX(3),SYMDIF(I,J))
      SYMMAX(3)=SQRT(SYMMAX(3))
```

compute the maximum distance at which sympathetic detonations can occur. The next section of coding:

```
 7019 IF(NMT.LT.1) GO TO 7045
      DO 7040 I=1,NTGTP
      RSP(I)=0.
      DO 7035 J=1,NMT
      NT=(I-1)*21+(J-1)*3
      DO 7030 K=1,3
      NT1=8*(NT+K-1)
      DO 7070 L=1,8
      IF(PROBIL(NT1+L).EQ.0.) GO TO 7022
 7070 CONTINUE
 7022 RNGSV(K)=RANGPR(NT1+L)
 7030 CONTINUE
      PRSHDO(I,J)=RNGSV(1)
      PRKLO(I,J)=RNGSV(2)
      PRDINO(I,J)=RNGSV(3)
      RSP(I)=AMAX1(RSP(I),RNGSV(1),RNGSV(3))
      RSPMAX=AMAX1(RSPMAX,RNGSV(1),RNGSV(3))
 7035 CONTINUE
      IF(MADIV.GT.0) RSP(I)=RSP(I)+30.
 7040 CONTINUE
      IF(MADIV.GT.0) RSPMAX=RSPMAX+30.
```

determines the minimum ranges at which each of the input probability functions are zero and computes values for the range of influence for each target type and the maximum range of influence. The largest possible diversion offset distance (30 feet) is added to the range of influence if target diversion is being considered. The next group of statements:

```
7045 XMIN=XMAX=0.
     DO 7060 I=1,5
7060 NIDBT(I)=0
     NDFWT=0
     IF(NDFWD.LT.1)GO TO 7085
     DO 7075 I=1,NDFWD
     N=IWTDEF(I)
7075 NIDBT(N)=NIDBT(N)+1
     DO 7080 I=1,5
     IF(NIDBT(I).GT.0) NDFWT=NDFWT+1
7080 CONTINUE
7085 CONTINUE
     DO 7100 I=1,NTGO
     XMAX=AMAX1(XMAX,TGTXOL(I))
7100 XMIN=AMIN1(XMIN,TGTXOL(I))
     XMAX=XMAX+RSPMAX
     XMIN=XMIN-RSPMAX
     IF (XMAX.GT.1638.) XMAX=1638.
     IF (XMIN.LT.-1638.) XMIN=-1639.
```

determine the number of defender targets by type, the total number of defender weapon types, and the maximum and minimum X coordinates within which mines will be retained for the case. The following statements:

```
     IF(NVAP.LT.1) GO TO9998
     DO 8200 I=1,NVAP
     COSA=COS(AYYVP(I)*.01745329258)
     SINA=SIN(AYYVP(I)*.01745329258)
     XORGVP=FLOAT(IFIX(XOVP(I)/100.))/100.
     YORGVP=YOVP(I)
     NWV=NWEPV(I)
     IF(NWV.LT.1)GO TO 8200
     DO 8190 J=1,NWV
     XDMP(I,J)=XORGVP+DMPIIX(I,J)*COSA+DMPIIY(I,J)*SINA
     YDMP(I,J)=YORGVP+DMPIIY(I,J)*COSA-DMPIIX(I,J)*SINA
8190 CONTINUE
8200 CONTINUE
```

transform the desired mean points of impact for each round in each indirect fire volley into the map coordinate system [Equations (38) and (39)]. The last group of statements in the subroutine:

```
     DO 8500 I=1,NTGTP
     AM=AMAX1(TARL(I),TARW(I))
     DO 8500 J=1,NVAP
     K=IWTVAP(J)
     THRSIG(K,I)=(4.44*AMAX1(REP(J),DEP(J))+AM*SQRT(EI(K,I,2)))**2
8500 CONTINUE
9998 RETURN
1480 FORMAT(1H1)
     END
```

compute the distances beyond which the effects of an indirect fire round are not considered.

Subroutine SETUP

This subroutine performs iteration-dependent calculations and determines the mine X and Y coordinates. The first executable statements:

```
      IT = 0
      TGTSPD=TGTVL2
      IF(MODE.LT.3)TGTSPD=TGTOVL
      REWIND 1
      REWIND 2
      IRUNS=IRUNS+1
      DO 300 I=1,5
      NKILLI(I)=NKILLD(I)=NRFBIT(I)=NRFBDT(I)=NDFDAM(I)=0
  300 NKILL(I)=0
      DO 305 I=1,NVAP
      NVLIDF(I)=NVFAEA(I)
  305 CONTINUE
      DO 310 I=1,7
  310 NMSWPT(I)=NMDET(I)=MIFBT(I)=0
      DO 315 J=1,20
      DO 315 I=1,15
  315 NDEFEA(I,J)=IABS(NDEFEA(I,J))
      DO 320 J=1,15
      ISVIFA(J+15)=0
  320 ISVIFA(J)=0
      DO 325 J=1,130
  325 TMTOFR(J)=9990.
      DO 330 I=1,100
      KDFTTN(I)=0
      NRFIRD(I)=0
  330 DELATM(I)=0.
      NKILLT=NSPLFT=0
      NTLOST=0
      NOBEVT=1
      THET=.017453295*THETA
      SINT=SIN(THET)
      COST=COS(THET)
      KNRS=0
      XW2=XWIDTH/2.0
      YL2=YLENGTH/2.0
      DO 210 I=1,547
  210 KABOOM(I)=0
      NOB = 0
      NOBTP2=8
      IT=0
      N=NRS+1
      NOB=NOB+N
```

initialize variables and set to zero the 547 words containing the mine detonation flag bits. The next statements:

```
      DO 200 I=1,N
  200 WRITE(1) XROAD(I),YROAD(I),NOBTP2,IT
```

write the X and Y coordinates of the travel path end points on Tape 1. Next, a double-nested DO LOOP is entered to determine the mine locations for the iteration. The statements:

```
      IF(NAP.LT.1) GO TO 160
      DO 146 J=1,NAP
  147 CALL RNORM(RN1)
      CALL RNORM(RN2)
      REWIND 2
      MT=MTFA(J)
      IT=0
      N=NSTICK(J)
      DO 146 I=1,N
      CALL RNORM(RN3)
      CALL RNORM(RN4)
      NOBTP2=MT
```

select two normal random numbers for use with the aiming error standard deviations. The mine type for the sortie aimpoint is determined, and, inside the inner DO LOOP, two normal random numbers are selected for use with the ballistic error standard deviations. If the nominal mine locations about the sortie aimpoint are read in from cards, the statements:

```
      IF(JSELDS(MT)) 120,130
  130 READ(2) ORX,ORY,NOBTP2
      IF(NOBTP2.NE.MT) GO TO 130
      GO TO 150
```

read the nominal mine X and Y coordinates from Tape 2. Otherwise, the statements:

```
  120 GO TO(122,125,125,122),JSELDS(MT)
  122 CALL RNORM(RSTART)
      ORX=XSWATH(J)/6.*RSTART
      IF(JSELDS(MT)-4) 123,126,123
  123 CALL RNORM(RSTART)
      ORY=YSWATH(J)/6.*RSTART
      GO TO 150
  125 ORX=XSWATH(J)*(RANF(DUMMY)-.5)
      IF(JSELDS(MT)-3) 126,123,126
  126 ORY=YSWATH(J)*(RANF(DUMMY)-.5)
```

determine the mean points of impact in range and deflection from either normal or uniform distributions of mines depending upon the value of JSELDS(MT). For normal distributions, the values of XSWATH(J) and YSWATH(J) contain six standard deviations; therefore, these values are divided by the value 6 to obtain the one-sigma values in the statements:

```
  150 ORX=ORX+RN1*SIGAD(J)+RN3*SIGBD(J)
      ORY=ORY+RN2*SIGAR(J)+RN4*SIGBR(J)
      OBX=AIMPTX(J)+ORX*COST+ORY*SINT
      OBY=AIMPTY(J)-ORX*SINT+ORY*COST
```

The mine X and Y coordinates with respect to the sortie aimpoint are computed [Equations (1) and (2)] and are then transformed into the map coordinate system [Equations (5) and (6)]. If the mine location is within the rectangle defining the area through which the targets are to travel, the statements:

```
      IF(ABS(OBX).GT.XW2.OR.ABS(OBY).GT.YL2) GO TO 146
  143 RN = RANF( DUMMY )
      IF(RN-DUDPRB(MT)) 20,20,25
   20 NOBTP2=NOBTP2+8
```

compare a uniform random number to the probability of mine malfunction [Equation (7)]. If the mine is a dud, the quantity 8 is added to the mine type to reflect this condition. If the mine has a fuze timing cycle or target counting capability, the statements:

```
   25 IF(INTIME(MT).EQ.0) GO TO 145
      RN = RANF (DUMMY)
      IT=RN*XCYCLE(MT)
      IF (KOUNT(MT).GT.0) IT=KOUNT(MT)
      IF ((RNK(MT).GT.0) IT=IFIX(IT*RN)+1
```

compute the random starting point for the mine [Equation (10)] or set the target count at which the mine will arm. This can be a random integer number of target counts varying from 1 up to a preset maximum. If Tactic 1 is being evaluated and if the mine is a dud, the mine is discarded. Otherwise, the statements:

```
  145 IF(MODE.EQ.1.AND.NOBTP2.GT.8) GO TO 146
      NOB = NOB + 1
      WRITE(1) OBX,OBY,NOBTP2,IT
  146 CONTINUE
      IF(NOB.LE.32767) GO TO 160
      PRINT 1000
 1000 FORMAT(* MORE THAN 32767 MINES IN MINEFIELD*)
      CALL EXIT
```

write the mine coordinates, mine type, and fuze timing cycle starting point or target count for arming (if any) on Tape 1. The final statements:

```
 160 NOBTP2=0
     WRITE(1) OBX,OBY,NOBTP2,IT
  10 MUSH = 0
     TOTSIM = 0.0
     DO 100 I=1,NTGO
     N=NTGTYP(I)
     NRADFI(I)=NRAI(N)
     IF(NTTICS(N).EQ.1) NSPLFT=NSPLFT+1
  99 TIMEMY(I)=0.
     TGTDEL(I)=0.
     SWPDEL(I)=0.
     NGTAW1(I)=NGTAW(I)
     TGTVEL(I)=TGTSPD
 100 CONTINUE
     IF(NDFWD.LT.1)RETURN
     DO 110 J=1,NDFWD
     N=IWTDEF(J)
     NRADFD(J)=NRAD(N)
 110 CONTINUE
     RETURN
     END
```

write a dummy record on Tape 1, initialize certain variables, and determine the number of targets which are capable of sweeping.

<u>Subroutine ROAD</u>

This subroutine transforms the mine locations into the travel path coordinate system and places the targets at the beginning of the travel path segment. The first executable statements:

```
    DIMENSION XLCF(100)
    NDFA=INDFA=0
    REWIND 1
    KNRS=KNRS+1
    DO 10 I=1,KNRS
 10 READ(1) XR1,YR1,NOBTP2,IT
    READ(1) XR2,YR2,NOBTP2,IT
 20 READ(1) ORX,ORY,NOBTP2,IT
    IF(NAP.LT.1) GO TO 25
    IF(NOBTP2.EQ.8) GO TO 20
```

read the X and Y coordinates of the end points of a travel path segment from Tape 1 and read the tape until the first mine coordinate record is found. The next statements:

```
 25 N2=NOBTP2
    LIT=IT
    A1=YR2-YR1
    A2=XR2-XR1
    IF(A2.EQ.0.) A2=.0000001
    THETR=ATAN2(A1,A2)-3.141592654/2.
    COSTR=COS(THETR)
    SINTR=SIN(THETR)
```

compute the sine and cosine of the angle that the directed travel path segment makes with the X axis of the map coordinate system. The statements:

```
      OBX=0.0
      OBY=0.0
      NOBTP2=0
      IT=IMINE=0
      CALL IPACK
      IOB(1)=IWORD
      YLENTH=OBY=SQRT(A2**2+A1**2)
      CALL IPACK
      NOB=2
      IOB(2)=IWORD
      NOBTP2=N2
      IT=LIT
      DO 45 I=1,130
   45 TMTOFR(I)=9999.0
      YMIN=99999
      YMAX=0.
```

pack the travel path segment boundary information into the IOB(5000) array and initializes the TMTOFR(130) array which is used to control the time at which direct or indirect fire rounds may be fired. A DO LOOP is next entered to consider each mine on Tape 1. The statements:

```
      DO 50 IMINE=1,32767
      IF(NOBTP2.EQ.0) GO TO 100
      OBX=(ORX-XR(I))*COSTR+(ORY-YR(I))*SINTR
      OBY=-(ORX-XR(I))*SINTR+(ORY-YR(I))*COSTR
```

transform the mine X and Y coordinates into the travel path coordinate system [Equations (8) and (9)]. If the mine lies within the travel path segment boundaries and within the range of influence of at least one target in the formation, the statements:

```
      IF(OBY.GT.YLENTH.OR.OBY.LE.0.) GO TO 40
      IF(OBX.LT.XMIN.OR.OBX.GT.XMAX) GO TO 40
      YMIN=AMIN1(YMIN,OBY)
      YMAX=AMAX1(YMAX,OBY)
      IDET=0
      IF(KNRS.GT.1) CALL BOOM(IDET,2)
```

call Subroutine BOOM to determine if the mine was detonated while the targets were traversing a previous travel path segment (if any). If the mine was not previously detonated, the statements:

```
      IF(IDET.EQ.1) GO TO 40
      CALL IPACK
      M=MOD(NOBTP2,8)
      IF(NOBTP2.GT.15)GO TO 29
      MIFBT(M)=MIFBT(M)+1
   29 NOB=NOB+1
```

pack the mine information into the variable IWORD. If more than 5,000 mines have been retained for the travel path segment, the statements:

```
      IF(NOB.LT.5001) GO TO 30
      PRINT 1000
 1000 FORMAT(*0MORE THAN 5000 MINES WITHIN RANGE OF INFLUENCE FOR A ROA
     *D SEGMENT*/20(1H/),*PROGRAM STOPS*,20(1H/))
      CALL EXIT
```

print an error message, and the program stops. Otherwise, the statements:

```
   30 IOB(NOB)=IWORD
   40 READ(1) ORX,ORY,NOBTP2,I1
   50 CONTINUE
```

place the mine information into the IOB(5000) array and read another record from Tape 1. When all mines have been processed, the statements:

```
  100 DO 120 I=1,NTGO
      KTSAV(I)=1
      IF(KNRS.EQ.1) GO TO 110
      IF(TGTYNW(I).GT.99994.) GO TO 120
  110 TGTYNW(I)=TGTYOL(I)
      TGTVEL(I)=TGTSPD
      IF(KNRS.EQ.1) GO TO 120
      TADJ=ABS(TGTYNW(I)/TGTVEL(I))
      DELTM=TGTDEL(I)+SWPDEL(I)
      TIMEMV(I)=TIMEMV(I)-TADJ-DELTM
      TGTYNW(I)=TGTYNW(I)-TGTVEL(I)*DELTM
  120 CONTINUE
```

initialize the target positions and velocities and adjust the target travel times at the beginning of the second and subsequent travel path segments. The following statements:

```
      TGTYSV=TGTYOL(1)
      LEFTIN=NTGO-NKILLT-NTLOST
      MUSH=0
      NOVT=0
      DO 121 I=1,100
  121 S(I)=0.
      ISVLST=1
      KTSAV(1)=0
```

initialize several variables. If indirect fire is employed on this travel path segment, the following statements:

```
      IF(NVAP.LT.1) GO TO 135
      IMINE=IT=0
      NOBTP2=16
      DO 130 J=1,NVAP
      DIRATK(J)=AYYVP(J)*.017453293-THETR
      IRD=AMOD(XOVP(J),100.)
      IROAD=IABS(IRD)
      IF(IROAD.NE.KNRS) GO TO 130
      IT=NTLCIF(J)
      IMINE=J
      XR=(XOVP(J)-IROAD)/10000.
      YR=YOVP(J)
      OBX=(XR-XRI)*COSTR+(YR-YRI)*SINTR
      OBY=-(XR-XRI)*SINTR+(YR-YRI)*COSTR
      IF(OBY.GT.YLENTH.OR.OBY.LE.0.) GO TO 125
      IF(OBX.LT.-1638..OR.OBX.GT.1638.) GO TO 125
      CALL IPACK
      NOB=NOB+1
      IF(NOB.LT.5001) GO TO 124
      PRINT 1000
      CALL EXIT
  124 IOB(NOB)=IWORD
  125 CONTINUE
  130 CONTINUE
      DO 134 J=1,NVAP
      NWV=NWEPV(J)
      IF(NWV.LT.1) GO TO 134
      DO 133 K=1,NWV
      ROTDMPX(J,K)=(XDMP(J,K)-XRI)*COSTR+(YDMP(J,K)-YRI)*SINTR
      ROTDMPY(J,K)=-(XDMP(J,K)-XRI)*SINTR+(YDMP(J,K)-YRI)*COSTR
  133 CONTINUE
  134 CONTINUE
```

transform the origin of the volley aimpoints into the travel path coordinate system [Equations (36) and (37)] and pack the information into the variable IWORD. The desired mean points of impact are also transformed into the travel path coordinate system [Equations (40) and (41)] and stored in the arrays ROTDMPX(10,10) and ROTDMPY(10,10). The next group of statements:

```
  135 IMINE=0
      IT=0
      L=0
      IF(ND.LT.1) GO TO 160
      OBX=0
      DO 150 I=1,ND
      IRD=AMOD(XRDFO(I),100.)
      IRD=IABS(IRD)
      IF(IRD.NE.KNRS) GO TO 150
      XR=FLOAT(IFIX(XRDFO(I)/100.))
      YR=FLOAT(IFIX(YRDFO(I)/100.))
      OBY=-(XR-XRI)*SINTR+(YR-YRI)*COSTR
      IF(OBY.GT.YLENTH.OR.OBY.LE.0.) GO TO 150
      NOBTP2=17
      IF(L)149,147
  147 L=1
      IT=IFIX(AMOD(YRDFO(I),100.))
      IT=IABS(IT)
  148 CALL IPACK
      NOB=NOB+1
      IF(NOB.LT.5001) GO TO 140
      PRINT 1000
      CALL EXIT
```

```
149 NOBTP2=18
    L=0
    GO TO 148
140 IOB(NOB)=IWORD
150 CONTINUE
```

transform the boundaries of the direct fire areas into the travel path coordinate system [Equation (24)] and pack the information into the variable IWORD. The statements:

```
160 IF(NDFAA.LT.1) GO TO 400
    DO 350 I=1,NDFWD
    DEFX(I)=(XODEF(I)-XR1)*COSTR+(YODEF(I)-YR1)*SINTR
    DEFY(I)=-(XODEF(I)-XR1)*SINTR+(YODEF(I)-YR1)*COSTR
350 CONTINUE
```

transform the coordinates of the position of the defenders into the travel path coordinate system. The last statements in the subroutine:

```
400 IF(LCFOPT.LT.1)RETURN
    NLCFCT=0
    DO 410 I=1,NTGO
    IF(NTGTYP(I).NE.LCFTT) GO TO 410
    NLCFCT=NLCFCT+1
    XLCF(NLCFCT)=TGTXOL(I)
410 CONTINUE
    DLCF=ALNGLC
    IF(LCFOPT.GT.1)DLCF=DBFAE
    IT=0
    IMINE=0
    NOBTP2=19
    OBY=YMIN-2.*DLCF
    OBY=AMAX1(OBY,0.)
420 OBY=OBY+DLCF
    IF(OBY.GT.YMAX) GO TO 500
    DO 430 I=1,NLCFCT
    OBX=XLCF(I)
    CALL IPACK
    NOB=NOB+1
    IOB(NOB)=IWORD
    IF(NOB.LT.5001) GO TO 430
    PRINT 1000
    CALL EXIT
430 CONTINUE
    GO TO 420
500 RETURN
    END
```

determine the position along the travel path segment that the line charges or fuel air explosives will be placed and pack this information into the variable IWORD.

Subroutine BOOM

This subroutine sets and checks the mine detonation flag bits contained in the KABOOM(547) array. The first executable statements:

```
      IWD=(IMINE-1)/60+1
      K=MOD(IMINE,60)-1
      IF(K.EQ.-1) K=59
```

compute the word and bit position within the word for the mine being considered. If the call to Subroutine BOOM was made for the purpose of recording that a mine has detonated, the statements:

```
      IF(N.GT.1) GO TO 200
  100 I=1
      KABOOM(IWD)=KABOOM(IWD).OR.SHIFT(I,K)
      RETURN
```

shift a 1 into the appropriate bit position. If the status of a mine is to be checked, the statements:

```
  200 IDET=SHIFT(KABOOM(IWD),-K).AND.1B
      RETURN
      END
```

place the bit, whether ON or OFF, into the variable IDET for interrogation in the calling routine.

Subroutine SORT

The purpose of this subroutine is to sort the IOB(5000) vector into increasing order by a method developed by Richard C. Singleton. Details pertaining to the sorting technique can be found in Algorithm 347 of the Collected Algorithms From the Communications of the Association for Computing Machinery. The listing is presented here for completeness.

```
      INTEGER A(N),IU(16),IL(16),T,TT
      M = 1
      I = 1
      J = N
    5 IF(I-J) 10,70,70
   10 K = I
      IJ = (J+I)/2
      T = A(IJ)
      IF(A(I)-T) 20,20,15
   15 A(IJ) = A(I)
      A(I) = T
      T = A(IJ)
   20 L = J
      IF(A(J)-T) 23,40,40
   23 A(IJ) = A(J)
      A(J) = T
      T = A(IJ)
      IF(A(I)-T) 40,40,27
   27 A(IJ) = A(I)
      A(I) = T
      T = A(IJ)
      GO TO 40
   30 A(L) = A(K)
      A(K) = TT
   40 L = L - 1
      IF(A(L)-T) 35,35,40
   35 TT = A(L)
   50 K = K + 1
      IF(A(K)-T) 50,53,53
   53 IF(K-L) 30,30,55
   55 IF((L-I)-(J-K)) 60,60,57
   57 IL(M) = I
      IU(M) = L
      I = K
      M = M + 1
      GO TO 80
   60 IL(M) = K
      IU(M) = J
      J = L
      M = M + 1
      GO TO 80
   70 M = M - 1
      IF(M) 75,110,75
   75 I = IL(M)
      J = IU(M)
   80 IF(J-I-1) 85,10,90
   85 IF(I-II) 87,5,87
   87 I = I - 1
   90 I = I + 1
      IF(I-J) 93,70,93
   93 T = A(I+1)
      IF(A(I)-T) 90,90,97
   97 K = I
  100 A(K+1) = A(K)
      K = K - 1
      IF(T-A(K)) 100,105,105
  105 A(K+1) = T
      GO TO 90
  110 RETURN
      END
```

Subroutine LOOPS

The purpose of this subroutine is to determine which target is involved in the next event. The event information in the IOB(5000) array has already been sorted so that the next event that a target will be involved in can be determined by incrementing the appropriate location in the KTSAV(100) array. The first executable statement:

```
KTSAV(ISVLST)=KTSAV(ISVLST)+1
```

increments the counter for the target that was considered in the last event. A DO LOOP is entered to consider each target, and the statements:

```
      DO 250 I=1,NTGO
      IF(TGTYNW(I)-100000.)110,110,100
  100 TGTYNW(I)=99999.
      TMTOFR(I)=9990.
      DIRDIS(I)=99999.
      GO TO 250
  110 DIRDIS(I)=99999.
```

remove the target from further consideration if it was damaged in the last event. If the target has not been damaged, the statements:

```
      IF(TGTYNW(I).GT.99970.) GO TO 250
  140 KT=KTSAV(I)
      IF(IOB(KT)+1) 210,205
  205 KTSAV(I)=KTSAV(I)+1
      GO TO 140
```

determine whether the next event that the target will be involved in has previously occurred. If it has been, the counter is incremented, and the determination is made again. Otherwise, the statements:

```
  210 IWORD=IOB(KT)
      CALL UNPACK
      N=NTGTYP(I)
      IF(NOBTP2.GT.15) GO TO 240
      M=MOD(NOBTP2,8)
```

unpack the event information. If a target/mine encounter is being evaluated, the statements:

```
      IF(M) 212,240
  212 IF(PRSWDO(N,M))220,215
  215 IF(PRDTNO(N,M))220,205
  220 XDIS=ABS(OBX-TGTXOL(I))
      IF(XDIS-RSP(N))240,205,205
```

compute the distance between the target and the mine when the target is at the point of closest approach to the mine [Equation (12)]. This computation is performed only if the mine type can be detected or detonated by the target. If the mine is outside of the range of influence of the target, a transfer is made to consider the next mine. Otherwise, the statements:

```
240 DIRDIS(I)=OBY-TGTYNW(I)
250 CONTINUE
```

compute the range distance which must be traveled by the target to reach the point of closest approach to the mine [Equation (11)]. After all active targets have been considered, the statements:

```
    ISAVE=1
    IVEL=0
    ISV=1
    SMLDIS=SMLDIS1=99999.
    DO 400 I=1,NTGO
    IF(SMLDIS-DIRDIS(I))350,350,310
310 ISAVE=I
    SMLDIS=DIRDIS(I)
350 IF(TGTVEL(I))360,400,360
360 IF(SMLDIS1-DIRDIS(I))400,400,380
380 SMLDIS1=DIRDIS(I)
    ISV=I
    IVEL=1
400 CONTINUE
```

determine the smallest range distance for all targets, and the smallest range distance for only the moving targets. The next statements:

```
TRAVTM=SMLDIS/TGTSPD
ISVLST=ISAVE
IF(TGTVEL(ISAVE).GT.0.)RETURN
IF(IVEL.LT.1) GO TO 580
```

compute the travel time to the next event for all targets. If the event target is stopped but at least one target is moving, the following statements:

```
TT=SMLDIS1/TGTSPD
IF(TT.LE.DELATM(ISAVE))GO TO 570
TRAVTM=DELATM(ISAVE)
RETURN
```

compute the travel time for the moving target that is closest to the event and if this travel time is greater than the delay that the event target is experiencing, the travel time to the next event is set to the delay time of the event target. Otherwise:

```
570 ISAVE=ISV
    ISVLST=ISV
    TRAVTM=TT
    RETURN
```

the event target is set to the moving target that is closest to the event. The last statements in the subroutine:

```
580 DO 590 I=1,NTGO
    TM(I)=DELATM(I)
    IPOS(I)=I
    IF(TGTYNH(I).GT.99990.)TM(I)=99999.
590 CONTINUE
    DO 700 I=1,NTGO
    IF(I.LT.2)GO TO 600
    IF(TM(I-1).GT.TM(I))GO TO 710
600 K=I
    DO 700 J=I,NTGO
    IF(TM(I).LT.TM(J))GO TO 700
    SAVE=TM(I)
    TM(I)=TM(J)
    TM(J)=SAVE
    KEEP=IPOS(I)
    IPOS(I)=IPOS(J)
    IPOS(J)=KEEP
700 CONTINUE
710 NUM=K-1
    DIS=99999.
    DO 750 I=1,NUM
    KPOS=IPOS(I)
    IF(DIRDIS(KPOS).GT.DIS) GO TO 750
    DIS=DIRDIS(KPOS)
    ISAVE=KPOS
750 CONTINUE
    ISVLST=ISAVE
    TRAVTM=TM(1)
    RETURN
    END
```

determine the event target by selecting the smallest delay time and the smallest event distance.

Subroutine EVENTC

This subroutine evaluates an event involving a target and a travel path segment boundary. The first executable statements:

```
TGTVSV=TGTVEL(ISAVE)
OBYPRT=OBY
```

save the target velocity and the boundary Y coordinate, as these variables may be changed. If the targets have not started moving, the event involves the entrance boundary, and the statements:

```
      IF(MUSH.EQ.1) GO TO 505
      OBY=99999.
      IOB(I)=-1
      MUSH=1
      IF(KNRS.NE.1) GO TO 1000
      TOTSIM=0.
      DO 200 I=1,NTGO
  200 TIMEMV(I)=0.
      GO TO 1000
```

remove the boundary from further consideration and initialize the total breach time and total target travel time if the first travel path segment has just been entered. If an exit boundary is involved, the statements:

```
  505 CONTINUE
      TGTYSV = TGTYNW(ISAVE)
      LEFTIN = LEFTIN - 1
 502  TGTYNW(ISAVE)=99991.
      IF(NDFA.LT.1) GO TO 511
      TMTOFR(ISAVE)=9990.
      DO 510 J=1,NDFA
      CALL STINT(ISVIFA,ISAVE,J,IBIT,KDFTIN,2)
  510 CONTINUE
  511 IF(KNRS.NE.NRS) GO TO 512
      N=NTGTYP(ISAVE)
      IF(NTTTCS(N).EQ.1) NSPLFT=NSPLFT-1
 512  TGTVEL(ISAVE)=0
 1000 RETURN
      END
```

remove the target from further consideration. If the target is exiting the last travel path segment and has sweeping capability, the counter for the number of targets remaining with sweeping capability is decremented. If there are any targets in a direct fire area, the event target is removed from further consideration by direct fire by a call to Subroutine STINT.

Subroutine DIVSET

The purpose of this subroutine is to control the direction of target diversion. When a target which must be diverted around is damaged, Subroutine DIVSET is called. The first executable statements:

```
      K=K1
      IF(XF(K)) 50,10,100
   10 NDVT=NDVT+1
      YDIV(NDVT)=TGTYNW(K)
      NTCOL(NDVT)=NCTAW(K)
      S(NDVT)=-1.
      GO TO 500
```

save the Y coordinate and column identification of the target if the target is not in the process of diverting around another damaged target. A flag is set so that future diversions at that location will be to the left. If the target which is damaged in this event is diverting to the left when damaged, the statements:

```
   50 S(ID)=1.
      GO TO 500
```

change the diversion direction for subsequent targets in the column. If the target is diverting to the right when damaged, a target path blockage is formed, and the statements:

```
  100 S(ID)=999.
      DO 200 I=1,NTGO
      IF(TGTYNW(I).GT.99990.) GO TO 200
      IF(NTCOL(ID).NE.NCTAW(I)) GO TO 200
      IF(TGTYNW(I).GT.YDIV(ID)+60.) GO TO 200
      TGTDEL(I)=TGTDEL(I)+D3DEL
      DELATM(I)=D3DEL
      TGTVEL(I)=0.
  200 CONTINUE
  500 RETURN
      END
```

remove the three damaged targets from the travel path and assess a time delay to all targets behind the blockage in the same column.

Subroutine DIVCHK

This subroutine determines whether a target is diverting around another target and, if so, computes the offset distance due to diversion. A DO LOOP considers each target which must be diverted around. The first executable statements:

```
      K=K1
      DO 50 I=1,NDVT
      ID=I
      IF(NCTAW(K).NE.NTCOL(I)) GO TO 50
      T1=TGTYNW(K)
      T2=YDIV(I)+60.
      T3=YDIV(I)-60.
      IF(T1.LT.T3.OR.T1.GT.T2) GO TO 50
      IF(S(I).EQ.999.) GO TO 50
```

determine whether the event target is in the same column and within 60 feet of the target which must be diverted around. If so, the statements:

```
   20 XFIX=S(I)*(SQRT(5625.-(T1-YDIV(I))**2)-45.)
      GO TO 100
   50 CONTINUE
  100 RETURN
      END
```

compute the target offset due to diversion around the damaged target [Equation (13)].

<u>Subroutine UNIT</u>

The purpose of this subroutine is to determine if the lead target of a group has been damaged and, if so, to move as a unit the targets associated with the lead target. A DO LOOP is entered to consider each target that is damaged in the event. The first executable statements:

```
      DO 200 K=1,NTGO
      IF(TGTYNW(K).LT.100000.) GO TO 200
      L=0
      DO 10 I=1,NTGO
      IF(TGTYNW(I).GT.99990.) GO TO 10
      IF(NGTAWI(I).NE.K) GO TO 10
      L=L+1
      NAS(L)=I
   10 CONTINUE
      IF (L.EQ.0) GO TO 200
```

determine whether any targets are associated with the damaged target as a group. If so, the next statements:

```
      KF=KB=0
      SMALY=99999.
      BIGY=-99999.
      DO 50 I=1,NTGO
      IF(I.EQ.K) GO TO 50
      IF(NCTAW(I).NE.NCTAW(K)) GO TO 50
      IF(NTGTYP(I).NE.NTGTYP(K)) GO TO 50
      IF(TGTYNW(I).GE.99999.) GO TO 50
```

determine whether a target of the same type as the damaged target is in the same column. For targets which meet this qualification, the statements:

```
      IF(TGTYNW(I).GT.TGTYNW(K)-100000.) GO TO 20
      IF(TGTYNW(I).LT.BIGY) GO TO 50
      KB=I
      BIGY=TGTYNW(I)
      GO TO 50
   20 IF(TGTYNW(I).GT.SMALY) GO TO 50
      KF=I
      SMALY=TGTYNW(I)
   50 CONTINUE
```

determine the closest ones in front of and behind the damaged target. If a target of the same type is ahead of the damaged target, the statements:

```
      IF(KF.EQ.0) GO TO 100
      DO 60 I=1,L
      NI=NAS(I)
   60 NGTAWI(NI)=KF
      GO TO 200
```

reassociate the remaining targets with the new lead target. If no such target is in front of the damaged target but one is behind, the statements:

```
  100 IF(KB.EQ.0) GO TO 130
      YFIX=TGTYNW(K)-BIGY-100000
      DO 110 I=1,L
      NI=NAS(I)
      TGTYNW(NI)=TGTYNW(NI)-YFIX
  110 NGTAWI(NI)=KB
      GO TO 200
```

move the remaining targets to reassociate them with the new lead target. If no targets which could be lead targets are in the column, the statements:

```
  130 DO 150 I=1,L
      NI=NAS(I)
      TGTYNW(NI)=99995.
      TMTOFR(NI)=9990.
      IF(IRUNS.EQ.IPRINT)PRINT 99999,NI
99999 FORMAT(* TGT LOST *,I4)
      TGTVEL(NI)=0.
      LEFTIN=LEFTIN-1
      NTLOST=NTLOST+1
      IF(NDFA.LT.1) GO TO 150
      DO 140 J=1,NDFA
      CALL STINT(ISVIFA,NI,J,IBIT,KDFTIN,2)
  140 CONTINUE
  150 CONTINUE
  200 CONTINUE
      RETURN
      END
```

remove the remaining targets from the simulation and from all direct fire areas and define them as "lost" to the mission. (Such targets are not included in the count of targets damaged.)

Subroutine TGTMIN

The purpose of this subroutine is to evaluate the interactions between a target and a mine. The first executable statements:

```
      TGTYSV=TGTYNW(ISAVE)
      KT=KTSAV(ISAVE)
      IPO=IH
      OBYPRT=OBY
      XFIX=0.
      KI=ISAVE
      NOBEVT=-NOBEVT
      IF(NDVT.GT.0) CALL DIVCHK
```

initialize several variables. If any targets which must be diverted around have been damaged, Subroutine DIVCHK is called to determine whether the event target must divert. The next statements:

```
      XFIXI=XFIX
      DISTPD=ABS(OBX-TGTXOL(ISAVE)-XFIX)
```

compute the lateral distance between the event target and the event mine [Equations (12) and (14)]. If Tactic 1 is being evaluated or if the event target is not capable of sweeping mines, the statements:

```
N=NTGTYP(ISAVE)
M=MOD(NOBTP2,8)
IF(NTTTRP(N).GT.0) GO TO 649
IF(NOBTP2.GT.15)RETURN
IF(MODE.LT.3) GO TO 200
IF(NTTTCS(N).LT.1) GO TO 200
```

provide a branch to the section of the subroutine that determines whether the mine detonates. Similar branches are provided by the statement:

```
IF(DISTPD.GE.PRSWDD(N,M)) GO TO 200
```

if the target/mine distance is greater than the maximum range at which the target can sweep the mine. The statements:

```
NTABLE=(N-1)*21+(M-1)*3+1
CALL TABINT(DISTPD,NTABLE)
```

determine which mine detection table is to be interpolated, and Subroutine TABINT performs a standard linear interpolation. A uniform random number is compared to the probability of mine detection by the statements:

```
NOBEVT=IABS(NOBEVT)
RN=RANF(DUMMY)
IF(RN.GT.PRBITY) GO TO 200
```

and if the mine is detected, the statements:

```
IPO=5HSWEPT
OBY=99987.
NMSWPT(M)=NMSWPT(M)+1
CALL BOOM(IDET,I)
IOB(KT)=-1
IF(NOBTP2.LT.8) NMDET(M)=NMDET(M)+1
IF(ISBL.GT.0.AND.ISYMP(I).GT.0) CALL SYMDET
```

remove the mine from further consideration. Subroutine BOOM turns on the detonation flag bit for the mine; if swept mines are blown-in-place, Subroutine SYMDET evaluates sympathetic detonations (if required). The statements:

```
DO 105 I=1,NTGO
IF(TGTYNW(I).GT.99969.) GO TO 105
IF(NCTAW(I).NE.NCTAW(ISAVE)) GO TO 105
SWPDEL(I)=SWPDEL(I)+TMSWP(M)
```

```
          DELATM(I)=TMSWP(M)
          TGTVEL(I)=0.
      105 CONTINUE
          GO TO 700
```

increment the sweep delay time and sets the velocity to zero for all active targets in the column. If the mine is not detected and if the mine employs a fuze timing cycle, the statements:

```
      200 IF(INTIME(M).LT.1) GO TO 649
          IF (KOUNT(M).GT.0) GO TO 649
          TOTSIM=TIMEMV(ISAVE)+TGTDEL(ISAVE)+SWPDEL(ISAVE)
          IF(AMOD(TOTSIM*60.+IT,XCYCLE(M)).GT.SECON(M)) RETURN
      649 CONTINUE
```

determine if the fuze is active [Equations (16) and (17)]. If the fuze is inactive, no further evaluation is required. If the fuze is active or if the mine has no timing cycle, the next step is to determine if the mine detonates. The statements:

```
          PRBITY=0
          IF(NOBTP2.GT.7) RETURN
          IF(DISTPD.GE.PRDTNO(N,NOBTP2)) RETURN
          NTABLE=(N-1)*21+(NOBTP2-1)*3+3
          CALL TABINT(DISTPD,NTABLE)
```

call Subroutine TABINT to perform a linear interpolation of the probability of mine detonation function if the mine is not a dud and if the target/mine distance is less than the maximum range at which the mine can be detonated. A uniform random number is compared to the probability of mine detonation by the statements:

```
          NOBEVT=IABS(NOBEVT)
          RN=RANF(DUMMY)
          IF (RN .LT. PRBITY) GO TO 650
          IF(NTTTRP(N).LT.2) RETURN
```

The evaluation ends if the mine does not detonate and the sweeping device is not a plow. If the random number is greater than the probability of mine detonation, the statements:

```
      IF(RANF(DUMMY).LT.PFEAF(M))RETURN
      NMSWPT(M)=NMSWPT(M)+1
      IOB(KT)=-1
      IPO=5HSWEPT
      CALL BOOM(IDET,1)
      RETURN
```

determine if the plowed mine can still function by comparing the probability value to a uniform random number. If the mine was swept, the mine is removed from further consideration. Subroutine BOOM is called to turn on the detonation flag for the mine. The next group of statements:

```
  650 IF (KOUNT(M).LE.0) GO TO 658
      IF (IT.LE.1) GO TO 658
      IT=IT-1
      CALL IPACK
      IOB(KT)=IWORD
      RETURN
```

determine whether the mine has counted the required number of targets if the target counting feature is being evaluated. If the required target count has not been achieved, the variable is decremented, the mine information is packed again, and the evaluation is completed. If the required target count has been achieved or if the mine does not arm itself after counting a predetermined number of targets, the mine is detonated. The statements:

```
  658 NMDET(M)=NMDET(M)+1
      OBY = 99972
      IF(ISYP.EQ.0)ISYP=1
      CALL BOOM(IDET,1)
      IPO=9HDETONATED
      IOB(KT)=-1
      IF(NTTTRP(N))710,659
  659 CONTINUE
```

remove the mine from further consideration. Subroutine BOOM is called to turn on the detonation flag for the mine; if this target type does not employ a roller or a plow as a sweeping device, a DO LOOP is entered to determine if any targets are damaged by the detonated mine. The statements:

```
      DO 690 K=1,NTGO
      IF(TGTYNM(K).GT.99969.) GO TO 690
      KI=K
      IF(K.NE.ISAVE) GO TO 660
      XFIX=XFIXI
      GO TO 670
  660 XFIX=0.
      IF(NDVT.GT.0) CALL DIVCHK
```

consider an active target; if any targets which must be diverted around have been damaged, Subroutine DIVCHK is called to determine whether the target being considered must divert. The statement:

```
570 DISTPD=(OBX-TGTXOL(K)-XF(X))**2+(OBYPRT-TGTYNW(K))**2
```

computes the target/mine distance [Equation (18)]. If the target/mine distance is less than the maximum range at which the target can be damaged, the statements:

```
    N=NTGTYP(K)
    PK=PRKLD(N,NOBTP2)**2
    IF(DISTPD.GT.PK) GO TO 690
    DISTPD=SQRT(DISTPD)
    NTABLE=(N-1)*21+(NOBTP2-1)*3+2
    CALL TABINT(DISTPD,NTABLE)
```

call Subroutine TABINT to perform a linear interpolation of the probability of target damage function. Next, a uniform random number is compared to the interpolated probability value. If the target is damaged, the statements:

```
    LEFTIN = LEFTIN - 1
    NKILLT=NKILLT+1
    NKILL(N)=NKILL(N)+1
    IF(NDFA.LT.1) GO TO 690
    DO 680 J=1,NDFA
    CALL STINT(ISVIFA,K,J,IBIT,KDFTTN,2)
680 CONTINUE
690 CONTINUE
    RN=RANF(DUMMY)
    IF(RN.GT.PRBITY) GO TO 690
    K1=K
    IF(NTTTMD(N).GT.0) CALL DIVSET
    TGTYNW(K)=TGTYNW(K)+100000.
    TMTOFR(K)=9990.
    TGTVSV=TGTVEL(K)
    TGTVEL(K)=0.
    IF(ISYP.EQ.1) ISYP=2
    IF(NTTTCS(N).GT.0) NSPLFT=NSPLFT-1
```

remove the target from further consideration, set the target velocity to zero, remove the target from all direct fire areas, and increment several counters. If the target must be diverted around by subsequent targets in the column, Subroutine DIVSET is called to save the target Y coordinate and set the diversion direction. The statements:

```
      IF(ISYMP(1).GT.0) CALL SYMDET
  700 RETURN
```

provide a call to Subroutine SYMDET if sympathetic detonations for mines are being evaluated. The statements:

```
  710 K1=ISAVE
      NMSWPT(M)=NMSWPT(M)+1
      PK=PRKLO(N,NOBTP2)
      IF(DISTPD.GT.PK)RETURN
      NTABLE=(N-1)*21+(NOBTP2-1)*3+2
      CALL TABINT(DISTPD,NTABLE)
```

evaluate a roller or plow interaction with a mine. If the target/mine distance is greater than the maximum range at which the target can be damaged, the evaluation ends. Otherwise, Subroutine TABINT is called to perform a linear interpolation of the probability of damage function. Next, a uniform random number is compared to the interpolated probability value. If the target is damaged, the statements:

```
      RN=RANF(DUMMY)
      IF(RN.GT.PROBTY)RETURN
      TGTYNW(ISAVE)=TGTYNW(ISAVE)+100000.
      TMTOFR(ISAVE)=9990.
      TGTVSV=TGTVEL(ISAVE)
      TGTVEL(ISAVE)=0.
      NSPLFT=NSPLFT-1
      LEFTIN=LEFTIN-1
      NKILLT=NKILLT+1
      NKILL(N)=NKILL(N)+1
      IF(NDFA.LT.1)RETURN
      DO 720 J=1,NDFA
      CALL STINT(ISVIFA,ISAVE,J,IBIT,KDFTTN,2)
  720 CONTINUE
      RETURN
      END
```

remove the target from further consideration, set the target velocity to zero, remove the target from all direct fire areas, and increment several counters.

Subroutine SYMDET

The purpose of this subroutine is to evaluate sympathetic detonations. Sympathetic detonations occur when a mine is sufficiently close to a detonating mine or an exploding direct or indirect fire round to itself detonate due to the disturbance. The first statements:

```
      DIMENSION XSYM(2,100),YSYM(2,100),NOBT(100)
      KNOB=NOB-2
      I1=1
      I2=2
      IF(NOBTP2-16)300,310,320
  300 KTS=KTSAV(ISAVE)
      MINNUM=1
      ISUB=1
      KNOBT=NOBT(1)=NOBTP2
      SOBX=XSYM(1,1)=OBX
      SOBY=YSYM(1,1)=OBYPRT
      GO TO 10
  310 KTS=KTSAV(ISAVE)
      ISUB=3
      J=NHEPV(IMIN)
      DO 315 K=1,J
      XSYM(I1,K)=ROTDMPX(IMINE,K)
      YSYM(I1,K)=ROTDMPY(IMINE,K)
  315 NOBT(K)=16
      MINNUM=J
      GO TO 10
  320 KTS=KTSAV(JIS)
      ISUB=2
      MINNUM=1
      NOBT(1)=17
      XSYM(1,1)=TGTXOL(IIS)
      YSYM(1,1)=TGTYNW(IIS)
```

provide local storage for the event X and Y coordinates and the mine or weapon type and initialize several variables prior to the evaluation. The X and Y coordinates of the impacting round or of the mine which detonated in the event are placed into the XSYM(2,100) and YSYM(2,100) arrays. This mine or round is evaluated against other mines; if any sympathetic detonations occur, the X and Y coordinates of the detonated mines are also saved for evaluation against other mines. The statements:

```
   10 NLST=MINNUM
      MINNUM=0
      YMAX=0.
      YMIN=99999.
      DO 20 I=1,NLST
      YMAX=AMAX1(YMAX,YSYM(I1,I))
   20 YMIN=AMIN1(YMIN,YSYM(I1,I))
```

determine the maximum and minimum Y coordinates of the mines or rounds. Next, all mines within the maximum sympathetic detonation range of the detonated mines are identified (comparing Y coordinate only). The statements:

```
      KTMIN=KTMAX=KTS1=KTS
   30 KTS1=KTS1-1
      IF(KTS1.LT.2) GO TO 40
      IF(IOB(KTS1).EQ.-1) GO TO 30
      IWORD=IOB(KTS1)
      CALL UNPACK
      IF(NOBTP2.GT.8) GO TO 30
      IF(YMIN-SYMMAX(ISUB).GT.OBY) GO TO 40
      KTMIN=KTS1
      GO TO 30
```

perform this function for mines with smaller Y coordinates than the value of YMIN, and the statements:

```
40 KTSI=KTS
50 KTSI=KTSI+1
   IF(KTSI.GT.KNOB) GO TO 60
   IF(IOB(KTSI).EQ.-1) GO TO 50
   IWORD=IOB(KTSI)
   CALL UNPACK
   IF(NOBTP2.GT.8) GO TO 50
   IF(YMAX+SYMMAX(ISUB).LT.OBY) GO TO 60
   KIMAX=KTSI
   GO TO 50
```

perform this function for mines with greater Y coordinates than the value of YMAX. Next, a DO LOOP is entered to determine which, if any, of the mines detonate sympathetically. The statements:

```
60 DO 120 I=KIMIN,KIMAX
   IF(IOB(I).EQ.-1) GO TO 120
   IWORD=IOB(I)
   CALL UNPACK
```

unpack the event information if the event has not previously occurred. Next, the mine is evaluated against the mines which have detonated in this event. The statements:

```
N=NOBTP2
IF(NOBTP2.GT.8) GO TO 120
DO 110 J=1,NLST
DIS=(OBX-XSYM(II,J))**2+(OBY-YSYM(II,J))**2
```

compute the square of the distance from the detonated mine to the mine being considered [Equation (19)], and the statements:

```
    IF(NOBT(J)-16)390,400,410
390 K=MOD(NOBT(J),8)
    IF(DIS.GT.SYMDIS(K,N)) GO TO 110
    GO TO 65
400 K=IWTVAP(IMINE)
    IF(DIS.GT.SYMDIF(K,N)) GO TO 110
    GO TO 65
410 K=IWTDEF(NDF)
    IF(DIS.GT.SYMDDF(K,N)) GO TO 110
```

compare this value to the square of the maximum range at which sympathetic detonations can occur for the mines involved with a detonating mine or round. If the mine detonates, the statements:

```
   65 MINNUM=MINNUM+1
      NMDET(N)=NMDET(N)+1
      IF(MINNUM.LE.100) GO TO 70
      WRITE(6,1000)
 1000 FORMAT(1H0,'MORE THAN 100 SYMPATHETIC DETONATIONS')
      CALL EXIT
   70 XSYM(12,MINNUM)=OBX
      YSYM(12,MINNUM)=OBY
      NOBT(MINNUM)=NOBTP2
      CALL BOOM(IDET,I)
      IOB(I)=-1
```

remove the mine from further consideration, save the mine coordinates, and call Subroutine BOOM (which turns on the mine detonation flag bit). If more than 100 mines sympathetically detonate, an error message is printed, and the program stops. If the optional output is required, the statements:

```
      IF(IPRINT.NE.IRUNS) GO TO 120
      IF(MINNUM.EQ.1) WRITE(6,1010)
 1010 FORMAT(' SYMPATHETIC DETONATIONS  OB-NUM  OBS-TYPE   OB X   OB Y')
      WRITE(6,1020) I,NOBTP2,OBX,OBY
 1020 FORMAT(26X,I5,I10,F8.1,F7.1)
      GO TO 120
  110 CONTINUE
  120 CONTINUE
```

print the mine sequential number, the mine type, and the mine X and Y coordinates for the sympathetically detonated mine. If any mines were detonated in this analysis, the statements:

```
      IF(MINNUM.EQ.0) GO TO 200
      I3=I1
      I1=I2
      I2=I3
      ISUB=1
      GO TO 10
```

provide for further evaluation of sympathetic detonations. Otherwise, the statements:

```
  200 NOBTP2=KNOBT
      OBX=SOBX
      OBYPRT=SOBY
      RETURN
      END
```

reset several variables which may have changed in the subroutine, and the evaluation is completed.

Subroutine PRINTO

The purpose of this subroutine is to print the optional output at the end of the event (if required). The first executable statements:

```
TOTSIM=TIMEMV(ISAVE)+TGTDEL(ISAVE)+SWPDEL(ISAVE)
IF(NOBTP2.EQ.17) GO TO 1520
IF(NOBTP2.EQ.18) GO TO 1530
IF(NOBTP2.EQ.16)RETURN
IF(NOBTP2-8)10,1500
```

compute the total breach time for the event target and if the event was a travel path boundary or direct fire area boundary, branches are provided to other sections of the subroutine. The next statements:

```
 10 DO 280 KI=1,11
    K6=KI*10
    K5=K6-9
    IF(K6.GT.NTGO) K6=NTGO
    PRINT 1001,(I,I=K5,K6)
    PRINT 1002,(KTSAV(I),I=K5,K6)
    PRINT 1003,(DIRDIS(I),I=K5,K6)
    IF(K6.EQ.NTGO) GO TO 40
280 CONTINUE
```

print the sequential number of the next event to be encountered by each target and the distance to the event. The statements:

```
40    TYPRIT = TGTYNW(ISAVE)
      TVELPR=TGTVEL(ISAVE)
      IF(TGTYNW(ISAVE).LT.99970.) GO TO 1004
      TYPRIT=TGTYSV
      TVELPR=TGTVSV
```

obtain the Y coordinate and velocity of the event target. The statements:

```
1004 WRITE(6,1400) ISAVE,NTGTYP(ISAVE),TYPRIT,TGTXOL(ISAVE),
    *TVELPR,TIMEMV(ISAVE),TOTSIM
     WRITE(6,1410)KTSAV(ISAVE),NOBTP2,OBX,OBYPRT,PRBITY,RN,IPO
```

print the sequential target number of the event target, the target type, the coordinates and velocity of the event target, the total time that the event target has been moving, the total breach time, the sequential number of the event, the event type and coordinates of the event, and the last interpolated probability and random number with a variable indicating that a mine was either swept or detonated in the event. If optional output has been printed for 200 events, the statements:

```
      WRITE(6,1420)
      NOBEVT=NOBEVT+1
      IF(NOBEVT.GT.200) IPRINT=0
```

turn off the optional output request variable to limit excessive output. Finally, the statements:

```
      N2=NTGO/2
      DO 1019 K=1,N2
      M=K+N2
      TOT2=DELATM(M)
      TOTDEL=DELATM(K)
 1019 WRITE(6,1120) K,NTGTYP(K),TGTYNW(K),TGTXOL(K),TGTVEL(K),TIMEMV(K),
     *TOTDEL,M,NTGTYP(M),TGTYNW(M),TGTXOL(M),TGTVEL(M),TIMEMV(M),
     *TOT2
      IF(M-NTGO)1440,1012
 1440 M=NTGO
      TOTDEL=DELATM(M)
      WRITE(6,1120)M,NTGTYP(M),TGTYNW(M),TGTXOL(M),TGTVEL(M),TIMEMV(M),
     *TOTDEL
 1012 RETURN
 1500 WRITE(6,1510)ISAVE,OBYPRT,TOTSIM
 1510 FORMAT(1X,9(1H*),* TRAVEL PATH BOUNDARY  EVENT TGT =*
     8I4,*  OB Y=*,F8.1,*  BREACH TIME=*,F8.3,9(1H*))
      RETURN
 1520 IPO=8HENTRANCE
      GO TO 1540
 1530 IPO=4HEXIT
 1540 WRITE(6,1545)IPO,IT,OBYPRT,ISAVE
 1545 FORMAT(1X,9(1H*),* DIRECT FIRE AREA *,A10,
     8* NUMBER *,I3,*  OB Y=*,F8.1,*  EVENT TGT*,I5,9(1H*))
      RETURN
```

print, for each target, the sequential target number, the target type, the target coordinates and velocity, the total time the target has been moving, and the delay time experienced by the target. The travel path segment boundary and direct fire area boundary information is also printed.

Subroutine PRINTR

The purpose of this subroutine is to print the results for each iteration and a periodic statistical summary. The formats for the output are determined at execution time and are a function of the various options being evaluated. The statements:

```
         DO 60 I=1.52
      60 DIST(I)=0.00
```

initialize an array used to store the variables used in the distribution output. For the first call to Subroutine PRINTR, the statements:

```
         IF(JMARK1.LT.1) GO TO 80
         DO 70 J=1.52
   70    XRG(J)=0.
         REWIND 7
         JMARK1=0
```

initialize an array that creates the variables used in the distribution output and rewinds an intermediate disk file on which the distribution data is stored. If iteration output is desired and the results of the first iteration is being printed or if the statistical summary was printed for the previous iteration, the statements:

```
         IF(ITEROP.LT.1) GO TO 100
         NTMAX=MAX0(NMT.NTGTP.NDFWT)
   80    IF(MOD(IRUNS.NOSTAT).NE.1) GO TO 100
         WRITE(6.5000) IEND.MODE.(NITBT(I).I=1.NTGTP)
         IF(NDFWT.GT.0) WRITE(6.5001)(NIDBT(I).I=1.NDFWT)
         IF(NMT.GT.0) WRITE(6.5002)(NMIN(I).I=1.NMT)
         IF(ITEROP.LT.1)GO TO 100
         WRITE(6.5003)
         WRITE(6.5004)
```

print page heading and column heading information. The page heading includes the run number, the tactic option being employed, the number of intruders and defenders by type, and the number of mines by type. Next, the statements:

```
  100    BIG=0.
         DO 110 I=1.NTGO
         SUM=TIMEMV(I)+TGTDEL(I)+SWPDEL(I)
         IF(SUM.LT.BIG) GO TO 110
         BIG=SUM
         TGTD=TGTDEL(I)
         SWPD=SWPDEL(I)
         TMMV=TIMEMV(I)
  110    CONTINUE
         TOTSIM=BIG
```

compute the total breach time. If iteration output is desired, a DO LOOP is entered to create the output lines by encoding the data into the OUT(16) array. ENCODE(N,M,HOL) is a Control Data Corporation system function which encodes N characters from Format M into the variable HOL.

```
      IF(ITEROP.LT.1) GO TO 310
      WRITE(6,2010)
120   DO 300 I=1,NTMAX
      DO 150 J=1,16
150   OUT(J)=1H
      IF(I.LT.2) ENCODE(5,1001,OUT(1)) IRUNS
      ENCODE(5,1001,OUT(2)) I
      IF(NTGTP.GE.1.AND.NMT.GT.0) ENCODE(6,1002,OUT(3)) NKILL(I)
      IF(NTGTP.GE.1.AND.NDFWT.GT.0) ENCODE(7,1004,OUT(4)) NKILLD(I)
      IF(NTGTP.GE.1.AND.NVAP.GT.0) ENCODE(7,1004,OUT(5)) NKILLI(I)
      IF(NDFWT.GE.1.AND.IRTFIR.GT.0) ENCODE(9,1006,OUT(6)) NDFDAM(I)
      IF(NTGTP.GE.1.AND.IRTFIR.GT.0) ENCODE(10,1007,OUT(7)) NRFBIT(I)
      IF(NDFWT.GE.1) ENCODE(8,1008,OUT(8)) NRFBDT(I)
      IF(I.GT.NMT) GO TO 180
      ENCODE(10,1007,OUT(9)) NMDET(I)
      ENCODE(10,1007,OUT(10)) MIFBT(I)
      ENCODE(8,1008,OUT(11)) NMSWPT(I)
180   IF(I.GT.1) GO TO 200
      IF(NGTAWT.GT.0) ENCODE(6,1002,OUT(12)) NTLOST
      IF(MADIV.GT.0) ENCODE(8,1013,OUT(13)) TGTD
      IF(MODE.GT.1) ENCODE(7,1014,OUT(14)) SWPD
      ENCODE(8,1013,OUT(15)) TMMV .
      ENCODE(8,1013,OUT(16)) TOTSIM
200   N=11
      IF(I.LT.2) N=16
      WRITE(6,2000) (OUT(K),K=1,N)
300   CONTINUE
```

The next statements:

```
310   DO 320 I=1,NTGTP
      DIST(I)=NKILL(I)
      DIST(I+5)=NKILLD(I)
      DIST(I+10)=NKILLI(I)
320   DIST(I+20)=NRFBIT(I)
      DO 330 I=1,NDFWT
      DIST(I+15)=NDFDAM(I)
330   DIST(I+25)=NRFBDT(I)
      DO 340 I=1,NMT
      DIST(I+30)=NMDET(I)
      DIST(I+37)=MIFBT(I)
340   DIST(I+44)=NMSWPT(I)
      DIST(52)=TOTSIM
```

store the data used in the distribution output into the DIST(52) array. If distribution data is desired, the statements:

```
      IF(IDISOP.LT.1) GO TO 360
      DO 350 I=1,52
350   XRG(I)=AMAX1(XRG(I),DIST(I))
      WRITE(7) DIST
```

determine the maximum value of each distribution output variable and store the distribution data on Tape 7. In the next statements:

```
360   DO 370 I=1,52
      STATAL(1,I)=STATAL(1,I)+DIST(I)
370   STATAL(2,I)=STATAL(2,I)+DIST(I)**2
```

the variables to be included in the statistical summary are saved. The sums and the sums of the squares for each of the variables are also computed. If statistical results are to be printed for this iteration, the statements:

```
      IF(MOD(IRUNS,NOSTAT).NE.0) RETURN
      RUNS=IRUNS
      IRN=IRUNS
      DO 380 I=1,52
      STATAL(3,I)=STATAL(1,I)/RUNS
      STATAL(4,I)=(STATAL(2,I)-(STATAL(1,I)**2)/RUNS)/(RUNS-1.0)
      IF(STATAL(4,I).GT.0.) STATAL(5,I)=SQRT(STATAL(4,I))
380   CONTINUE
      WRITE(6,6000)
      IF(NMT.GT.0) WRITE(6,6010)((STATAL(I,J),I=3,5),J=1,NTGTP)
      K=NTGTP+5
      IF(NDFWT.GT.0) WRITE(6,6020)((STATAL(I,J),I=3,5),J=6,K)
      K=NTGTP+10
      IF(NVAP.GT.0) WRITE(6,6030)((STATAL(I,J),I=3,5),J=11,K)
      K=NDFWT+15
      IF(NDFWT.GT.0) WRITE(6,6040)((STATAL(I,J),I=3,5),J=16,K)
      K=NTGTP+20
      IF(NDFWT.GT.0) WRITE(6,6050)
      IF(IRTFIR.GT.0) WRITE(6,6060)((STATAL(I,J),I=3,5),J=21,K)
      K=NDFWT+25
      IF(NDFWT.GT.0) WRITE(6,6070)((STATAL(I,J),I=3,5),J=26,K)
      K=NMT+30
      IF(NMT.LT.1) GO TO 400
      WRITE(6,6080)((STATAL(I,J),I=3,5),J=31,K)
      K=NMT+37
      WRITE(6,6090)((STATAL(I,J),I=3,5),J=38,K)
      K=NMT+44
      IF(MODE.EQ.3) WRITE(6,6100)((STATAL(I,J),I=3,5),J=45,K)
400   WRITE(6,6110)(STATAL(I,52),I=3,5)
```

compute and print the means, variances, and standard deviations for each variable. If distribution output is desired, the last statements in the subroutine:

```
      IF(IDISOP.GT.0) CALL DISTR(NMT,NTGTP,NDFWT)
      RETURN
```

provide a call to Subroutine DISTR to print the distribution data.

Subroutine DISTR

The purpose of this subroutine is to print the distribution data. The formats for the output are determined at execution time and are a function of the various options being evaluated. The statements:

```
 DATA IFMT/10H(1X,8HINTE,5HRVAL,,3HA7,,3HA7,,3HA7,,3HA7,,
*3HA7,,3H3X,,3HA7,,3HA7,,3HA7,,3HA7,,3HA7,,3H3X,,
*3HA7,,3HA7,,3HA7,,3HA7,,3HA7,,3H3X ,1H),6*(1H )/
 DATA JFMT/10H(2X,5HCLAS,10HS/(3X12,6X,3HR7,,3HR7,,3HR7,,
*3HR7,,3HR7,,3H3X,,3HR7,,3HR7,,3HR7,,3HR7,,3HR7,,3H3X,,
*3HR7,,3HR7,,3HR7,,3HR7,,3HR7,,3H3X),1H),6*(1H )/
 DATA NFMT/10H(1X,8HINTE,5HRVAL,,3HA7,,3HA7,,3HA7,,3HA7,,
*3HA7,,3HA7,,3HA7,,3H3X,,3HA7,,3HA7,,3HA7,,3HA7,,3HA7,,
*3HA7,,3HA7,,3H3X ,1H),8*(1H )/
 DATA KFMT/10H(2X,5HCLAS,10HS/(3X12,6X,3HR7,,3HR7,,3HR7,,
*3HR7,,3HR7,,3HR7,,3HR7,,3H3X,,3HR7,,3HR7,,3HR7,,3HR7,,
*3HR7,,3HR7,,3HR7,,3H3X),1H),8*(1H )/
```

provide Hollerith data from which the output formats can be created. The statements:

```
   XRN=1.0/FLOAT(IRN)
   DO 20 I=1,52
   INT(I)=IFIX(XRG(I))/20+1
   IF(INT(I).LT.11) GO TO 10
   L=ALOG10(FLOAT(INT(I)))
   L1=10*L
   INT(I)=(INT(I)/L1+1)*L1
10 DO 20 K=1,21
20 DIST5(K,I)=0.0
   REWIND 7
```

computed the interval over which the distributions are defined. The statements:

```
   DO 50 I=1,IRN
   READ(7)DIST
   DO 50 J=1,52
   K1=(DIST(J)-.01)/FLOAT(INT(J))+2.0
   IF(DIST(J).EQ.0.0)K1=1
50 DIST5(K1,J)=DIST5(K1,J)+XRN
```

compute the distribution data for each variable to be output. The next statements:

```
   KZ=0
   WRITE(6,1000)
   WRITE(6,1001)
   WRITE(6,1007)
   DO 85 I=1,27
   LFMT(I)=IFMT(I)
   MFMT(I)=JFMT(I)
85 CONTINUE
   DO 90 I=1,15
   IOUT(I)=1H
   DO 90 J=1,21
   OUT(J,I)=1H
90 CONTINUE
```

print the first page headings and initialize the output arrays. The next statements:

```
      IF(NMT.LT.1) GO TO 110
      DO 100 I=1,NTGTP
      IOUT(I)=INT(I)
      LFMT(I+2)=3HI7,
      MFMT(I+2)=5HF7.3,
   94 DO 95 J=1,21
      OUT(J,I)=DIST5(J,I)
   95 CONTINUE
  100 CONTINUE
```

store the intervals and the distribution data for the intruders damaged by mines into the output arrays and create the output formats for the number of intruder target types. The next statements:

```
  110 IF(NDFWT.LT.1) GO TO 180
      DO 150 I=1,NTGTP
      I8=I+8
      IOUT(I+5)=INT(I+5)
      LFMT(I8)=3HI7,
      MFMT(I8)=5HF7.3,
  144 DO 145 J=1,21
      OUT(J,I+5)=DIST5(J,I+5)
  145 CONTINUE
  150 CONTINUE
```

store the intervals and distribution data for the intruders damaged by direct fire into the output arrays and create the output formats for the number of intruder target types. The next statements:

```
  180 IF(NDFWT.LT.1) GO TO 200
      DO 195 I=1,NTGTP
      I14=I+14
      IOUT(I+10)=INT(I+10)
      LFMT(I14)=3HI7,
      MFMT(I14)=5HF7.3,
  189 DO 190 J=1,21
      OUT(J,I+10)=DIST5(J,I+10)
  190 CONTINUE
  195 CONTINUE
  200 WRITE(6,LFMT)IOUT
      WRITE(6,MFMT)(I,(OUT(I+1,J),J=1,15),I=KZ,20)
```

store the intervals and distribution data for the intruders damaged by indirect fire and print the output data. The next statements:

```
      IF(NDFWT.LT.1) GO TO 500
      DO 210 I=1,15
      IOUT(I)=1H
      DO 210 J=1,21
      OUT(J,I)=1H
  210 CONTINUE
      DO 215 I=1,27
      LFMT(I)=IFMT(I)
      MFMT(I)=JFMT(I)
  215 CONTINUE
      WRITE(6,1002)
      WRITE(6,1007)
      DO 250 I=1,NDFWT
      IOUT(I)=INT(I+15)
      LFMT(I+2)=3HI7,
      MFMT(I+2)=5HF7.3,
      DO 240 J=1,21
      OUT(J,I)=DIST5(J,I+15)
  240 CONTINUE
  250 CONTINUE
      DO 285 I=1,NIGTP
      IOUT(I+5)=INT(I+20)
      LFMT(I+8)=3HI7,
      MFMT(I+8)=5HF7.3,
      DO 280 J=1,21
      OUT(J,I+5)=DIST5(J,I+20)
  280 CONTINUE
  285 CONTINUE
      DO 300 I=1,NDFWT
      IOUT(I+10)=INT(I+25)
      LFMT(I+14)=3HI7,
      MFMT(I+14)=5HF7.3,
      DO 295 J=1,21
      OUT(J,I+10)=DIST5(J,I+25)
  295 CONTINUE
  300 CONTINUE
      WRITE(6,LFMT)IOUT
      WRITE(6,MFMT)(I,(OUT(I+1,J),J=1,15),I=KZ,20)
```

initialize the storage arrays, write new headings, store the intervals and distribution data, and create the output formats. The output is printed for defenders damaged, the rounds fired by the intruders, and the rounds fired by the defenders. The statements:

```
      WRITE(6,1003)
  500 WRITE(6,1000)
      IF(NMT.LT.1) GO TO 700
      DO 510 I=1,27
      LFMT(I)=NFMT(I)
  510 MFMT(I)=KFMT(I)
      DO 520 I=1,15
      IOUT(I)=1H
      DO 520 J=1,21
      OUT(J,I)=1H
  520 CONTINUE
      WRITE(6,1008)
      WRITE(6,1005)
      WRITE(6,1008)
      DO 550 I=1,NMT
      IOUT(I)=INT(I+30)
      LFMT(I+2)=3HI7,
      MFMT(I+2)=5HF7.3,
      DO 540 J=1,21
      OUT(J,I)=DIST5(J,I+30)
  540 CONTINUE
  550 CONTINUE
      DO 570 I=1,NMT
      IOUT(I+7)=INT(I+37)
      LFMT(I+10)=2HI7
      MFMT(I+10)=4HF7.3
      DO 560 J=1,21
      OUT(J,I+7)=DIST5(J,I+37)
  560 CONTINUE
  570 CONTINUE
      WRITE(6,LFMT) (IOUT(I),I=1,14)
      WRITE(6,MFMT)(I,(OUT(I+1,J),J=1,14),I=KZ,20)
```

initialize the storage arrays, write new headings, and provide for storage of distribution data into the output arrays while creating the output formats. The output is printed for mines detonated and mines in field. The statements:

```
      WRITE(6,1003)
700   DO 710 I=1,27
      LFMT(I)=NFMT(I)
      MFMT(I)=KFMT(I)
710   CONTINUE
      LFMT(13)=3HI7,
      MFMT(13)=5HF7.3,
      DO 720 I=1,15
      IOUT(I)=1H
      DO 720 J=1,21
      OUT(J,I)=1H
720   CONTINUE
      DO 780 I=1,NMT
      IOUT(I)=INT(I+44)
      LFMT(I+2)=3HI7,
      MFMT(I+2)=5HF7.3,
      DO 770 J=1,21
      OUT(J,I)=DISTS(J,I+44)
770   CONTINUE
780   CONTINUE
      IOUT(10)=INT(52)
      DO 790 J=1,21
      OUT(J,10)=DISTS(J,52)
790   CONTINUE
      WRITE(6,1008)
      WRITE(6,1006)
      WRITE(6,1008)
      WRITE(6,LFMT)(IOUT(I),I=1,14)
      WRITE(6,MFMT)(I,(OUT(I+1,J),J=1,14),I=KZ,20)
      RETURN
      END
```

provide for storage of the distribution data into the output arrays and create the output formats. The output is printed for mines swept and breach time.

Subroutine TABINT

The purpose of •this subroutine is to perform a standard linear interpolation [Equation (15)] for any of the probability functions. The first executable statements:

```
10     NB=NTABLE*8-7
       NE=NB+7
       DO 50 K5=NB,NE
       IF (DISTPD.GE.RANGPR(K5).AND.DISTPD.LE. RANGPR(K5+1)) GO TO 55
50     CONTINUE
       GO TO 60
```

determine the table location in the function arrays and the two range values which bracket the distance to be interpolated. The statements:

```
55    PRBITY=PROBIL(K5)+ (DISTPD-RANGPR(K5))/ (RANGPR(K5+1) - RANGPR(K5)
     2    )* (PROBIL(K5+1)-PROBIL(K5))
      GO TO 70
60    PRBITY=0.
70    RETURN
      END
```

perform the interpolation.

Subroutine RNORM

The purpose of this subroutine is to select a random variable from a normal distribution [Equations (3) and (4)]. This is accomplished by first selecting a uniform random number and then evaluating a polynomial using the uniform random number. The statements:

```
      RN19 = RANF(DUMMY)
      Q = ABS(1.-2.0*RN19)
      Q = .5*(1.0-Q)
      Q = -2.*ALOG(Q)
      V = SQRT(Q)
      SIGN = 1.
      IF(RN19-.5) 10,10,20
   10 SIGN=-1.
   20 Q=2.515517+.802853*V+.010328*V*V
      QQ = 1.+1.432788*V+.189259*V*V+.0013208*V*V*V
      RSTART=(V-Q/QQ)*SIGN
      RETURN
      END
```

perform this function, returning random variables with a mean of zero and a standard deviation of 1.

Subroutine IPACK

The purpose of this subroutine is to pack the event information into the variable IWORD. The word contains the event X and Y coordinates, the starting point for the mine timing cycle or the required target count for arming (if applicable), the event type, and the sequential mine number. The first executable statements:

```
      IX = OBX * 10.0
      IY = OBY * 10.0
      IWORD = 0
```

compute integer values of the mine or boundary coordinates with one decimal-digit accuracy and set the word to zero. The statements:

```
IWORD=IWORD.OR.IMINE
IWORD=IWORD.OR.SHIFT(NOBTP2,15)
IWORD=IWORD.OR.SHIFT(IT,20)
IWORD=IWORD.OR.SHIFT(IABS(IX),28)
IF(IX.LT.0) IWORD=IWORD.OR.100000000000000B
IWORD=IWORD.OR.SHIFT(IY,43)
RETURN
END
```

pack the information as described in Table 2 of the Mathematical Model. The SHIFT function is a Control Data Corporation library function which shifts the bits right or left.

Subroutine UNPACK

The purpose of this subroutine is to unpack the event information which was packed by Subroutine IPACK; the process is simply the reverse of that used in Subroutine IPACK. The first executable statements:

```
OBY=FLOAT(SHIFT(IWORD,-43).AND.177777B)/10.
OBX=FLOAT(SHIFT(IWORD,-28).AND.37777B)/10.
ITEMP=IWORD.AND.100000000000000B
IF(ITEMP.NE.0) OBX=-OBX
```

unpack the event X and Y coordinates and set the sign of the X coordinate. The next statements:

```
    NOBTP2=SHIFT(IWORD,-15).AND.37B
    IMINE=IWORD.AND.77777B
10  IT= SHIFT(IWORD,-20).AND.377B
20  RETURN
    END
```

unpack the event type and the event sequential number.

Subroutine NDFIRE

The purpose of this subroutine is to evaluate the effects of the indirect fire rounds employed against the intruding targets. The first executable statements:

```
BIGG(X)=.5*SQRT(1.-EXP(-.63*X**2))
PI=3.141592654
SRPI=SQRT(PI)
IWT=IWTVAP(IVAP)
ICMHE=1
IF(NSUB(IWT).LT.1) ICMHE=2
```

```
COSIMP=COS(ANGIMP(IVAP)*.01745329258)
SINIMP=SIN(ANGIMP(IVAP)*.01745329258)
ANG=DIRATK(IVAP)
COSANG=COS(ANG)
SINANG=SIN(ANG)
NH=NWEPV(IVAP)
IF(IRUNS.NE.IPRINT)GO TO 90
NVOL=NVFAEA(IVAP)-NVLIDF(IVAP)+1
WRITE(6,1000)IVAP,NVOL,IWT
90 CONTINUE
```

compute several variables which are independent of the target and round and print the optional output, if required. The statements:

```
DO 500 I=1,NTGO
IF(TGTYNW(I).GT.99990.) GO TO 500
XT=TGTXOL(I)
YT=TGTYNW(I)
ITT=NTGTYP(I)
SURVPR=1.
```

consider each active target and determine the target X and Y coordinate and target type. The following statements:

```
DO 480 J=1,NH
EIVAL=EI(IWT,ITT,2)
KODEI=EI(IWT,ITT,1)
XW=ROTOMPX(IVAP,J)
YW=ROTOMPY(IVAP,J)
```

consider each round employed at the volley aimpoint, and determine the value of the effectiveness index, the code for the effectiveness index used, and the X and Y coordinates of the desired mean points of impact. The statements:

```
RO=ABS((XW-XT)*SINANG+(YW-YT)*COSANG)
DO=ABS(-(XW-XT)*COSANG+(YW-YT)*SINANG)
DSQ=RO**2+DO**2
IF(DSQ.GT.THRSIG(IWT,ITT)) GO TO 480
```

compute the distance in range and deflection from the center of the intruder target to the desired mean point of impact [Equations (42) and (43)] and if the round impacted near enough to the target to cause damage, the statements:

```
APHD=PHD(IWT,ITT)
IF(ICMHE.GT.1) GO TO 110
POWER=-(NSUB(IWT)*RELSUB(IWT)*EIVAL)/(PI*PATRAD(IWT)**2)
IF(POWER.GT.-227.) GO TO 100
APHD=1
```

```
    GO TO 105
150 APHD=1.-EXP(POWER)
```

compute the probability of damage given the target is in the pattern [Equation (45)] for the improved conventional munition (ICM). The next statements:

```
105 ETL=ETW=SRPI*PATRAD(IWT)
110 GO TO (120,140,150,160),KODEI
```

compute the effective target length and width based on the radius of the pattern for the ICM weapon type [Equation (44)] and branch to the appropriate section of the subroutine depending on the code for the effectiveness index. For high explosive (HE) munitions described in terms of MAE_f the following statements:

```
120 IF(ICMME.LT.2) GO TO 130
    ALWRAT=1.-.8*COSIMP
    ETL=2.*SQRT(EIVAL*ALWRAT/PI)
    ETW=ETL/ALWRAT
```

compute the effective target length and width [Equations (47) and (48)] based on the ratio of the target length to the target width [Equation (46)]. The statements:

```
130 DENOM=17.6*REP(IVAP)**2+ETL**2
    RSSP=ETL/SQRT(DENOM)*EXP((-4.*RO**2)/DENOM)
    DENOM=17.6*DEP(IVAP)**2+ETW**2
    DSSP=ETW/SQRT(DENOM)*EXP((-4.*DO**2)/DENOM)
135 PKK=RSSP*DSSP*RELRND(IWT)*APHD
    GO TO 450
```

compute the single shot probability of hit in range and deflection [Equations (49) and (50)] and the single shot probability of damage [Equations (51) and (67)]. The next statements:

```
140 ETW=SQRT(EIVAL)
    ETL=ETW/SINIMP
    GO TO 220
```

compute the effective target length and width based on the square root of the vulnerable area (VA_N) and the sine of the angle of fall at impact for this munition [Equations (53) and (54)]. The statements:

```
150 ETL=ETW=SQRT(EIVAL)
    GO TO 220
```

compute the effective target length and width based on the square root of the mean area of effectiveness (MAE_b) for blast [Equation (52)]. If the effectiveness index is in terms of effective miss distance (EMD), the statements:

```
160 IF(TARRAD(ITT))170,180
170 ETL=ETW=SRPI*(TARRAD(ITT)*EIVAL)
    GO TO 190
180 ETL=TARL(ITT)+2.*EIVAL
    ETW=TARW(ITT)+2.*EIVAL
```

compute the effective target length and width [Equations (55), (56), and (57)]. If the height of the target is input, the statements:

```
190 IF(TARHT(ITT))200,220
200 SHADOL=TARHT(ITT)*SINIMP/COSIMP
```

compute the target shadow length [Equation (58)]. If the shadow length is greater than the effective miss distance, the statements:

```
    IF(SHADOL.LT.EIVAL) GO TO 220
    IF(TARRAD(ITT))205,210
205 ETL=(ETL**2+2.*TARRAD(ITT)*(SHADOL-EIVAL))/ETL
    GO TO 220
210 ETL=(ETL*ETW+TARW(ITT)*(SHADOL-EIVAL))/ETW
```

recompute the effective target length [Equations (59) and (60)]. The statements:

```
220 A1=(ETL+2.*RO)/(2.96*REP(IVAP))
    A2=ABS(ETL-2.*RO)/(2.96*REP(IVAP))
    B1=(ETW+2.*DO)/(2.96*DEP(IVAP))
    B2=ABS(ETW-2.*DO)/(2.96*DEP(IVAP))
    RSSP=BIGG(A1)+SIGN(1.,ETL-2.*RO)*BIGG(A2)
    DSSP=BIGG(B1)+SIGN(1.,ETW-2.*DO)*BIGG(B2)
    GO TO 135
```

compute the range single shot probability of hit and deflection single shot probability of hit [Equations (61) through (66)]. The probability of target survival for the volley is computed by the statement:

```
450 SURVPR=SURVPR*(1.-PKK)
490 CONTINUE
```

If the probability of target survival has been computed, the statements:

```
    IF(SURVPR.EQ.1.) GO TO 500
    PDAM=1.-SURVPR
    RN=RANF(DUMMY)
```

compute the probability of target damage [Equation (68)] and a uniform random number is obtained. The random number is compared to the probability of target damage [Equation (69)] and if the target is damaged, the statements:

```
    IF(RN.GT.PDAM) GO TO 490
    IF(IRUNS.NE.IPRINT) GO TO 485
    WRITE(6,1001)I,XT,YT,PDAM
485 TGTYNW(I)=TGTYNW(I)+100000.
    TGTYSV=TGTVEL(I)
    TMTOFR(I)=9990.
    TGTVEL(I)=0.
    LEFTIN=LEFTIN-1
    IF(NTTTCS(I).GT.0)NSPLFT=NSPLFT-1
    NKILLT=NKILLT+1
    NKILLI(ITT)=NKILLI(ITT)+1
```

print the optional output, if required, and increment several counters. The last statements in the subroutine:

```
    IF(NDFA.LT.1)GO TO 500
    DO 487 L=1,NDFA
487 CALL STINT(ISVIFA,I,L,IBIT,KOFTTN,2)
    GO TO 500
490 IF(IRUNS.EQ.IPRINT)WRITE(6,1002)I,XT,YT,PDAM
500 CONTINUE
    RETURN
    END
```

remove the intruder from all direct fire areas and print additional output, if required.

Subroutine DIRFIR

The purpose of this subroutine is to evaluate the effects of the direct fire munitions against either the intruder or defender targets. The variable IDAM controls whether direct fire or return fire is being delivered. The first executable statements:

```
      BIGG(X)=.5*SQRT(1.-EXP(-.63*X**2))
      ID=IDAM
      IDAM=0
      ITT=NTGTYP(IIS)
      IWT=IWTDEF(NDF)
      L=IWT
      IF(ID.GT.1) L=ITT
      BREL=AREL(L,ID)
      BCEP=ACEP(L,ID)
      KODEI=AEI(IWT,ITT,2*ID-1)
      EIVAL=AEI(IWT,ITT,2*ID)
      IF(KODEI.GT.1) GO TO 50
      IND=IDP(NDF,KI,ID)
```

initialize several variables. If the effectiveness index is in terms of the mean area of effectiveness for fragmentation in the ground plane (MAE_f), the statements:

```
      ALWRAT=1.-.8*AI(IND)
      ETL=2.*SQRT(EIVAL*ALWRAT/3.141592654)
      ETW=ETL/ALWRAT
      DENOM=17.6*AREP(IND)**2+ETL**2
      RSSP=ETL/SQRT(DENOM)
      DENOM=17.6*ADEP(IND)**2+ETW**2
      DSSP=ETW/SQRT(DENOM)
      SSPD=RSSP*DSSP*BREL
      GO TO 100
```

compute the target length-to-width ratio [Equation (25)], the effective target length and width [Equations (26) and (27)], and the single shot probability of damaged based on the range and deflection single shot probability of hit [Equations (28), (29), and (30)]. The statements:

```
50    IF(BCEP.GT.0.) GO TO 60
      XD=(TGTXOL(IIS)-DEFX(NDF))**2
      YD=(TGTYNW(IIS)-DEFY(NDF))**2
      RNG=SQRT(XD+YD)
      BCEP=.001*RNG*ABS(BCEP)
```

compute the distance between the intruder and defender, and convert the circular error probable from mils to feet [Equation (31)]. The next statements:

```
60      DENOM=1.7*BCEP
        IF(ID.GT.1) GO TO 70
        VERT=TARHT(ITT)
        HORIZ=2.*TARRAD(ITT)
        IF(HORIZ.LT..01) HORIZ=(TARL(ITT)+TARW(ITT))/2
        GO TO 80
```

compute the vertical and horizontal dimensions of the intruder. If direct fire munitions are employed against the defender, the statements:

```
70      VERT=DEFHT(IWT)
        HORIZ=2.*DEFRAD(IWT)
        IF(HORIZ.LT..01) HORIZ=(DEFL(IWT)+DEFW(IWT))/2
```

compute the vertical and horizontal dimensions of the defender. In the next statements:

```
80      AI=HORIZ/DENOM
        BI=VERT/DENOM
        RSSP=2.*BIGO(AI)
        DSSP=2.*BIGG(BI)
        SSPD=RSSP*DSSP*BREL*EIVAL
```

the single shot probability of damage [Equations (32), (33), and (34)] is computed. The last statements in the subroutine:

```
100     RN=RANF(DUMMY)
        IF(RN.LT.SSPD) IDAM=1
        PRBITY=SSPD
        RETURN
        END
```

obtain a uniform random number. The random number is compared to the single shot probability of damage [Inequality (35)], and, if the target is damaged, the variable IDAM is set to one to so indicate to the calling routine.

Subroutine CKEVTM

The purpose of this subroutine is to determine if any time ordered events should occur before the distance related event takes place and to sequence the events in the proper order. The possible time ordered events are direct fire shots, return fire shots, or the delivery of the second or subsequent volley at an indirect fire aimpoint. The first statements:

```
      DIMENSION TM(130),IPOS(130)
      IF(NDFA.GT.0) GOTO 50
      IF(INDFA.GT.0) GO TO 50
```

provide for local storage and determine if any time related events have previously occurred. If time ordered events have not occurred previously and the event is not an encounter of a direct fire area entrance boundary, the statements:

```
      IF(NOBTP2.LT.16.OR.NOBTP2.GT.18) GO TO 20
      IF(NOBTP2.GT.16) GO TO 15
      INDFA=1
      GO TO 20
   15 CALL STINT(ISVIFA,ISAVE,IT,IBIT,KDFTTN,1)
      NDFA=MAX0(IT,NDFA)
      CALL TGTMOV
   16 DO 18 J=1,NDFWD
      IF(NDEFEA(IT,J).LT.1) GO TO 18
      NDF=NDEFEA(IT,J)+100
      IF(TMTOFR(NDF).GT.0.0.AND.TMTOFR(NDF).LT.9000.) GO TO 18
      TMTOFR(NDF)=0
   18 CONTINUE
      RETURN
   20 CALL TGTMOV
      RETURN
```

provide for a call to Subroutine TGTMOV. If the intruder has encountered a direct fire area entrance boundary, Subroutine STINT is called to save this intruder number in the ISVIFA array for subsequent evaluation. Then, Subroutine TGTMOV is called, and all defenders that may fire into the direct fire area are determined. Control is then transferred to the calling routine. If there are time ordered events to occur, the next statements:

```
   50 DO 60 I=1,130
      IPOS(I)=I
      TM(I)=TMTOFR(I)
   60 CONTINUE
      DO 100 I=1,130
      DO 90 J=1,130
      IF(TM(I)-TM(J))90,90,85
   85 KEEP=IPOS(I)
      IPOS(I)=IPOS(J)
      IPOS(J)=KEEP
      SAVE=TM(I)
      TM(I)=TM(J)
      TM(J)=SAVE
   90 CONTINUE
      IF(TM(I).GT.TRAVTM) GO TO 120
  100 CONTINUE
  120 NUMCNT=MIN0(I,130)
```

sort the event times for all time ordered events until an event time is found which is greater than the travel time to the next position related event. If the position related event in the next event to occur, the statements:

```
      IF(NUMCNT.GT.1) GO TO 150
      CALL TGTMOV
      IF(NOBTP2.NE.17) RETURN
      CALL STINT(ISVIFA,ISAVE,IT,IBIT,KOFTTN,1)
      NDFA=MAX0(IT,NDFA)
      GO TO 16
```

provide for a call to Subroutine TGTMOV, and, if the intruder has encountered an entrance to a direct fire area, Subroutine STINT is called to save the intruder number in the ISVIFA array for subsequent evaluation. Next, a DO LOOP is entered to consider each time ordered event. The statements:

```
  150 NUM=NUMCNT-1
      ISHOT=0
      DO 1000 MI=1,NUM
      M=IPOS(MI)
      TTOI=TMTOER(M)
```

initialize the variable that signals that a time related event may occur and determine the event to occur and the event time. If the time ordered event can occur, the statements:

```
      IF(TTOI.GT.9000.) GO TO 1000
      TT=TRAVTM
      TRAVTM=TTOI
      CALL TGTMOV
      TRAVTM=TT-TTOI
```

provide a call to Subroutine TGTMOV and decrement the travel time to the position related event by this event time. The next statements:

```
      IF(M.GT.120) GO TO 750
      IF(M.LT.101) GO TO 500
```

provide branching to sections of the subrcutine that evaluate indirect fire volleys and intruder targets returning direct fire. If the event is one in which the defender employs direct fire munitions, the statements:

```
      NDF=M-100
      IF(NRADFD(NDF).LT.1) GO TO 900
      NDTYP=IWTDEF(NDF)
```

determine the defender number and, if the defender has any rounds remaining, the defender type is obtained. Next, three nested DO LOOPs are evaluated to determine if this defender may fire at an intruder. The statements:

```
      DO 300 I=1,5
      IPRR=ITGTPR(NDTYP,I)
      IF(IPRR.LT.1) GO TO 1000
```

consider each priority value from the defenders ordered list of intruder types to fire upon. If the priority value is zero, the defender cannot fire, and the next time related event is considered. If there are intruder types that the defender may shoot at, the statements:

```
      DO 280 IIS=1,NTGO
      IF(NTGTYP(IIS).NE.IPRR) GO TO 280
```

consider each intruder. If the intruder type is of the type the defender may fire upon, the statements:

```
      DO 270 K=1,NDFA
      CALL STINT(ISVIFA,IIS,K,IBIT,KDFTTN,3)
      IF(IBIT.LT.1) GOTO 270
      IF(NDEFEA(K,NDF).LT.1) GO TO 270
      GO TO 320
  270 CONTINUE
  280 CONTINUE
  300 CONTINUE
      GO TO 1000
```

consider each direct fire area. Subroutine STINT is called to determine if this intruder is in a direct fire area. If the intruder may be fired upon by the defender, the statements:

```
  320 TMTOFR(M)=TMBRD(NDTYP)
      KI=K
      IDAM=1
      ISHOT=1
      CALL DIRFIR(IDAM)
      IF(ISYMP(2).GT.0) CALL SYMDET
      NRADFD(NDF)=NRADFD(NDF)-1
      IF(NRADFD(NDF).LT.1) TMTOFR(M)=9991.
      NRFBDT(NDTYP)=NRFBDT(NDTYP)+1
```

increment several counters and provide a call to Subroutine DIRFIR. If sympathetic detonations are evaluated for direct fire munitions, Subroutine SYMDET is called. If optional output is required, the statements:

```
      IF(IRUNS.NE.IPRINT) GOTO 340
      AKIL=8H MISSED
      IF(IDAM.GT.0)AKIL=8H HIT HIM
      PRINT 9003,NDF,NDTYP,IIS,NIGTYP(IIS),AKIL,PRBITY
```

print the defender number and type, the intruder number and type, a message indicating whether the intruder was damaged by the direct fire munition, and the single shot probability of damage. If the intruder was damaged, the statements:

```
340 IF(IDAM.LT.1) GO TO  475
    TGTYNW(IIS)=TGTYNW(IIS)+100000.
    IF(NGTAWT.GT.0)CALL UNIT
    LEFTIN=LEFTIN-1
    TGTVEL(IIS)=0.
    TMTOFR(IIS)=9999.
    CALL STINT(ISVIFA,IIS,K,IBIT,KDFTTN,2)
    INTYP=NIGTYP(IIS)
    NKILLD(INTYP)=NKILLD(INTYP)+1
    NKILLT=NKILLT+1
    IF(NITTCS(INTYP).GT.0) NSPLFT=NSPLFT-1
    KI=IIS
    XFIX=0.0
```

increment several counters, provide calls to Subroutine UNIT if any intruders are associated as a group, and Subroutine STINT to turn the flag bit off for this intruder in the direct fire area. If the intruder must be diverted around by subsequent intruders in the column, the statement:

```
    IF(NITTMD(INTYP).GT.0)CALL DIVSET
```

provides a call to Subroutine DIVSET to save the intruder Y coordinate and set the dimension direction. The next statements:

```
475 J=0
    DO 485 I=1,NTGO
    CALL STINT(ISVIFA,I,K,IBIT,KDFTTN,3)
    IF(IBIT.LT.1) GO TO 485
    NRFIRD(I)=NRFIRD(I)+1
    IF(NRFIRD(I)-NRBA)485,480,485
480 TMTOFR(I)=0.
    J=1
485 CONTINUE
    IF(J)50,990
```

consider each intruder. If an intruder has observed the required number of rounds to be able to return fire, the array containing the times for the time ordered events is updated and a sort of the updated array is performed. If the time ordered event is one in which the intruder is returning fire, the statements:

```
500 NINTT=NTGTYP(M)
    IF(NRADFI(M).LT.1)GO TO 900
```

determine the intruder type. If the intruder has direct fire rounds remaining, three nested DO LOOPs are evaluated to determine if this intruder may fire at a defender. The statements:

```
    DO 600 I=1,5
    IPRR=IDFOPR(NINTT,I)
    IF(IPRR.LT.1) GO TO 1000
```

consider each priority value from the intruders ordered list of defender types to fire upon. If the priority value is zero, the intruder cannot fire and the next time ordered event is considered. If there are defender types the intruder may shoot at, the statements:

```
    DO 590 J=1,NDFWD
    IF(IHTDEF(J).NE.IPRR) GO TO 590
```

consider each defender. If the defender type is of the type the intruder may shoot at, the statements:

```
    DO 580 K=1,NDFA
    IF(NDEFEA(K,J).LT.1) GO TO 580
    CALL STINT(ISVIFA,M,K,IBIT,KDFTTN,3)
    IF(IBIT.LT.1) GO TO 580
    GO TO 620
580 CONTINUE
590 CONTINUE
600 CONTINUE
    GO TO 1000
```

consider each direct fire area. Subroutine STINT is called to determine if the intruder may fire from the direct fire area at a defender. If a defender may receive return fire, the statements:

```
520 TMTOFR(M)=TMBRI(NINTT)
    KI=K
    IDAM=2
    NDF=NDEFEA(K,J)
    ISHOT=1
    IIS=M
    CALL DIRFIR(IDAM)
    NRADFI(IIS)=NRADFI(IIS)-1
    IF(NRADFI(IIS).LT.1)TMTOFR(M)=9990.
    NRFBIT(NINTT)=NRFBIT(NINTT)+1
```

increment several counters and provide a call to Subroutine DIRFIR. If optional output is required, the statements:

```
IF(IRUNS.NE.IPRINT) GO TO 640
AKIL=8H MISSED
IF(IDAM.GT.0) AKIL=8H HIT HIM
PRINT 9005,M,NINTT,NDF,IWTDEF(NDF),AKIL,PRBITY
```

print the intruder number and type, the defender number and type, a message indicating whether the defender was damaged, and the single shot probability of damage. If the defender was damaged, the statements:

```
640 IF(IDAM.LT.1) GO TO 990
    NDEFEA(K,J)=-NDF
    NDTYP=IWTDEF(NDF)
    NDFDAM(NDTYP)=NDFDAM(NDTYP)+1
    TMTOFR(NDF+100)=9999.
    GO TO 990
```

increment several counters. If the time ordered event is one in which the second or subsequent indirect fire volley is involved, the statements:

```
750 IVAP=M-120
    IF(NVLIDF(IVAP).LT.1)GO TO 900
    CALL NDFIRE
    TMTOFR(M)=TDBIFV(IVAP)
    NVLIDF(IVAP)=NVLIDF(IVAP)-1
    ISHOT=1
    GO TO 990
```

determine the volley aimpoint number. If all volleys have not been delivered at this aimpoint, a call to Subroutine NDFIRE is provided and several counters incremented. The next statements:

```
900 TMTOFR(M)=9990.
    GO TO 1000
```

set the element of the array containing the times for the time ordered events to 9990 to indicate that an event will no longer be considered on a time basis. The next statements:

```
 990 IF(TIMTOFR(M) GT TRAVTM)GO TO 1000
     GO TO 50
1000 CONTINUE
```

determine if the time for a time ordered event to occur is less than the travel time to the next position related event, and if so, provides branching to the section of the routine that will sort the array containing the times for the time ordered events to occur. Otherwise, the next time ordered event is considered. The last statements in the subroutine:

```
     IF(ISHOT)50,1050
1050 IF(NOB(P2-17)20,15,20
     END
```

evaluate the signal that a time related event occurred, and, if one did occur, appropriate sections of the routine are branched to.

Subroutine STINT

The purposes of this subroutine are to turn on a bit to indicate that an intruder has entered a direct fire area, to turn off a bit to indicate that an intruder has exited a direct fire area, and to test a bit to determine if an intruder is located within a direct fire area. The first executable statements:

```
K=INT
KT=IT
I=1
IF(K.LT.59) GO TO 10
KT=IT+15
K=K-59
```

save the intruder number and the direct fire area number. For the intruder target numbers greater than 58, the direct fire area number is incremented by 15 and the intruder target number is decremented by 59. The variable KT is used for the subscript of the ISV(30) array and the variable K is used for the number of the bit in the word. The next statement:

```
10 GO TO (20,50,100),N
```

transfers to the proper section of the routine for the option desired. If the call to Subroutine STINT was made for the purpose of recording an intruder in a direct fire area, the statements:

```
20 ISV(KT)=ISV(KT).OR.SHIFT(1,K)
   KDFTTN(INT)=KDFTTN(INT)+1
   RETURN
```

shift a 1 into the appropriate bit position and increment the counter for the number of direct fire areas this intruder target is located in. If Subroutine STINT was called when an intruder left a direct fire area, the statements:

```
50 ISW=0
   J=ISW
   KK=J.OR.SHIFT(1,K)
   KK=.NOT.KK
   ISV(KT)=ISV(KT).AND.KK
   KDFTTN(INT)=KDFTTN(INT)-1
   RETURN
```

turn the flag bit off to so indicate and decrement the count of direct fire areas this intruder is located in. The last statements in the subroutine:

```
100 IBIT=SHIFT(ISV(KT),-K).AND.1B
    RETURN
    END
```

test the status of an intruder and place the bit whether ON or OFF into the variable IBIT for interrogation in the calling routine.

Subroutine EXPSWP

The purpose of this subroutine is to evaluate the effects of line charges and fuel air explosives as sweeping devices against the mines within the range of influence. The first statements:

```
XLOC=OBX
KT=KTSAV(ISAVE)
IOB(KT)=-1
NB=NOBTP2
```

save the event X coordinate and remove the event from further consideration. If line charges are employed, the following statements:

```
IF(IRUNS.EQ.IPRINT) WRITE(6,1000)
IF(LCFOPT.GT.1)GO TO 20
YDIST=OBY+ALNGLC
RANGE=AWIDLC
GO TO 50
```

set the forward and lateral limits of the line charge pattern effects. The following statements:

```
20 YLOC=OBY+DFTFAE
   YDIST=YLOC+RADFAE
   YST=YLOC-RADFAE
   RANGE=RADFAE**2
```

define the limits of the FAE pattern effects [Equations (20), (21), and (22)]. The next statements:

```
30 KT=KT+1
   IF(IOB(KT).LT.0) GO TO 30
   IWORD=IOB(KT)
   CALL UNPACK
   IF(NOBTP2-8)40,200,30
40 IF(OBY.LT.YST) GO TO 30
   GO TO 60
```

determine whether a mine is within range of the FAE effects. For line charges, the next statements:

```
50 KT=KT+1
   IF(IOB(KT).LT.0) GO TO 50
   IWORD=IOB(KT)
   CALL UNPACK
   IF(NOBTP2-8)60,200,50
60 IF(OBY.GT.YDIST) GO TO 200
```

determine whether a mine is within the forward limits of the line charge effects. The statements:

```
DIST=ABS(XLOC-OBX)
IF(LCFOPT.GT.1)DIST=DIST**2+(YLOC-OBY)**2
IF(DIST.GT.RANGE) GO TO 50
```

determine the lateral distance from the mine to the center of the exploding line charge or FAE. If the distance is greater than the effective range of the sweeping device, another mine is chosen for consideration. Next, a uniform random number is compared to the probability of detonation from line charge or FAE effects [Inequality (23)]. If the mine was detonated, the statements:

```
RN=RANF(DUMMY)
IF(RN.GT.PDLCF)GO TO 50
IF(IRUNS.EQ.IPRINT) WRITE(6,1010) NOBTP2,OBX,OBY
NMSWPT(NOBTP2)=NMSWPT(NOBTP2)+1
NMDET(NOBTP2)=NMDET(NOBTP2)+1
CALL BOOM(IDET,1)
IOB(KT)=-1
GO TO 50
```

remove the mine from further consideration and increment several counters. Subroutine BOOM is called to turn on the detonation flag for the mine. After all the mines for this travel path segment have been considered, or when a mine is located which is outside the forward effects of the line charge or FAE, a DO LOOP is next entered to increment the sweep delay for all active targets in the column. The statements:

```
200 DO 250 I=1,NTGO
    IF(TGTYNW(I).GT.99969.)GO TO 250
    IF(NCTAW(I).NE.NCTAW(ISAVE))GO TO 250
    SWPDEL(I)=SWPDEL(I)+TMDLCF
    DELATM(I)=TMDLCF
    TGTVEL(I)=0.
250 CONTINUE
    OBX=XLOC
    NOBTP2=NB
    RETURN
    END
```

consider an active target in the same column as the event target and increment the sweep delay time by the time delay assessed for employment of line charges or FAE.

Subroutine TGTMOV

The purpose of this subroutine is to move all active intruders the event distance and time and to adjust the assessed delays and event times by the time for the next event. The first statements:

```
DO 600 I=1,NTGO
IF(TGTYNW(I).GT.99990.) GO TO 600
IF(TGTVEL(I).GT.0.) GO TO 500
DELATM(I)=DELATM(I)-TRAVTM
```

```
      IF(DELATM(I).GT.0.00001) GO TO 550
```

decrement the delay time for the active intruders that are stopped. If the time for the next event is greater than the remaining delay time, the following statements:

```
      TGTVEL(I)=TGTSPD
      DTM=ABS(DELATM(I))
      DELATM(I)=0.
      TGTYNW(I)=TGTYNW(I)+TGTSPD*DTM
      TIMEMV(I)=TIMEMV(I)+DTM
      IF(TMTOFR(I).GT.9000.) GO TO 600
      TMTOFR(I)=TMTOFR(I)-DTM
      IF(TMTOFR(I).LT.0.)TMTOFR(I)=0.
      GO TO 600
```

reset the intruder velocity, initialize the delay time for the intruders, and adjust the time to fire by the remaining delay time. The next statements:

```
  500 TGTYNW(I)=TGTYNW(I)+TGTSPD*TRAVTM
      TIMEMV(I)=TIMEMV(I)+TRAVTM
  550 IF(TMTOFR(I).GT.9000.) GO TO 600
      TMTOFR(I)=TMTOFR(I)-TRAVTM
      IF(TMTOFR(I).LT.0.) TMTOFR(I)=0
  600 CONTINUE
```

move the active intruders the event distance and time, and adjust the time to fire for all active direct fire intruders by the time for the next event. If there are any defender direct fire weapons, the statements:

```
      IF(NDFWD.LT.1) GO TO 750
      NEND=NDFWD+100
      DO 700 I=101,NEND
      IF(TMTOFR(I).GT.9000.) GO TO 700
      TMTOFR(I)=TMTOFR(I)-TRAVTM
      IF(TMTOFR(I).LT.0.) TMTOFR(I)=0
  700 CONTINUE
```

adjust the time to fire for all active defenders. The last statements in the subroutine:

```
  750 IF(NVAP.LT.1) RETURN
      NEND=120+NVAP
      DO 900 I=121,NEND
      IF(TMTOFR(I).GT.9000.) GO TO 900
      TMTOFR(I)=TMTOFR(I)-TRAVTM
      IF(TMTOFR(I).LT.0.) TMTOFR(I)=0.
  900 CONTINUE
```

```
RETURN
END
```

adjust the time to fire for all indirect fire volley aim-points.

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